```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.datasets import make_classification
from sklearn.linear_model import LogisticRegression, SGDClassifier
from mlxtend.plotting import plot_decision_regions
from sklearn.utils import shuffle
```

```
!pip install --upgrade --no-cache-dir gdown
!gdown 1Won6xkyYCcJLJ7eMpVt5VA_4P0tE1nb7
```

```
Requirement already satisfied: gdown in /usr/local/lib/python3.10/dist-packages (4.7.3)
Collecting gdown
  Downloading gdown-5.0.0-py3-none-any.whl (16 kB)
Requirement already satisfied: beautifulsoup4 in /usr/local/lib/python3.10/dist-packages (from gdown) (4.11.2)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from gdown) (3.13.1)
Requirement already satisfied: requests[socks] in /usr/local/lib/python3.10/dist-packages (from gdown) (2.31.0)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages (from gdown) (4.66.1)
Requirement already satisfied: soupsieve>1.2 in /usr/local/lib/python3.10/dist-packages (from beautifulsoup4->gdown) (2.5)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests[socks]->gdown) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests[socks]->gdown) (3.6)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests[socks]->gdown) (2.0.7)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests[socks]->gdown) (2023.11.17)
Requirement already satisfied: PySocks!=1.5.7,>=1.5.6 in /usr/local/lib/python3.10/dist-packages (from requests[socks]->gdown) (1.7.1)
Installing collected packages: gdown
  Attempting uninstall: gdown
    Found existing installation: gdown 4.7.3
    Uninstalling gdown-4.7.3:
      Successfully uninstalled gdown-4.7.3
Successfully installed gdown-5.0.0
Downloading...
From: https://drive.google.com/uc?id=1Won6xkyYCcJLJ7eMpVt5VA_4P0tE1nb7
To: /content/data_banknote_authentication.txt
100% 46.4k/46.4k [00:00<00:00, 78.9MB/s]
```

```
df = pd.read_csv('/content/data_banknote_authentication.txt')
df
```

	x1	x2	x3	x4	y
0	3.62160	8.66610	-2.8073	-0.44699	0
1	4.54590	8.16740	-2.4586	-1.46210	0
2	3.86600	-2.63830	1.9242	0.10645	0
3	3.45660	9.52280	-4.0112	-3.59440	0
4	0.32924	-4.45520	4.5718	-0.98880	0
...	...	...	...	...	...
1367	0.40614	1.34920	-1.4501	-0.55949	1
1368	-1.38870	-4.87730	6.4774	0.34179	1
1369	-3.75030	-13.45860	17.5932	-2.77710	1
1370	-3.56370	-8.38270	12.3930	-1.28230	1
1371	-2.54190	-0.65804	2.6842	1.19520	1

1372 rows × 5 columns

```
shuffled_data = shuffle(df)
shuffled_data.to_csv('created_data.csv', index=False)
print(shuffled_data)
```

```
            x1       x2        x3       x4  y
638   2.7213   7.0500  -0.58808  0.41809  0
67    2.4235   9.5332  -3.07890 -2.77460  0
531   3.3583  10.3567  -3.73010 -3.69910  0
1171 -3.8552   3.5219  -0.38415 -3.86080  1
386  -2.4953  11.1472   1.93530 -3.46380  0
...      ...      ...       ...      ... ..
289   3.2422   6.2265   0.12224 -1.44660  0
701   5.5910  10.4643  -4.38390 -4.33790  0
```

```
1192 -4.4018 -12.9371  15.65590 -1.68060  1
640   4.1665  -0.4449   0.23448  0.27843  0
429   2.5503  -4.9518   6.37290 -0.41596  0

[1372 rows x 5 columns]
```

```
df2 = pd.read_csv('/content/created_data.csv')
df2
```

	x1	x2	x3	x4	y
0	2.7213	7.0500	-0.58808	0.41809	0
1	2.4235	9.5332	-3.07890	-2.77460	0
2	3.3583	10.3567	-3.73010	-3.69910	0
3	-3.8552	3.5219	-0.38415	-3.86080	1
4	-2.4953	11.1472	1.93530	-3.46380	0
...	...	...	...	...	...
1367	3.2422	6.2265	0.12224	-1.44660	0
1368	5.5910	10.4643	-4.38390	-4.33790	0
1369	-4.4018	-12.9371	15.65590	-1.68060	1
1370	4.1665	-0.4449	0.23448	0.27843	0
1371	2.5503	-4.9518	6.37290	-0.41596	0

1372 rows × 5 columns

```
class_counts = df2['y'].value_counts()

# نمایش تعداد نمونه‌ها برای هر کلاس
print(class_counts)
```

```
0    762
1    610
Name: y, dtype: int64
```

```
class_0_samples = df2[df2['y'] == 0].sample(610)
class_1_samples = df2[df2['y'] == 1].sample(610)

# ایجاد دیتافریم جدید با 1220 نمونه انتخابی
df1 = pd.concat([class_0_samples, class_1_samples], ignore_index=True)
```

Logistic Regression (from Scratch)

```
def sigmoid(x):
    return 1 / (1 + np.exp(-x))
```

```
def logistic_regression(x, w):
    y_hat = sigmoid(x @ w)
    return y_hat
```

Binary Cross Entropy (BCE)

```
def bce(y, y_hat):
    loss = -(np.mean(y*np.log(y_hat) + (1-y)*np.log(1-y_hat)))
    return loss
```

Gradient

```
def gradient(x, y, y_hat):
    grads = (x.T @ (y_hat - y)) / len(y)
    return grads
```

Gradient Descent

```
def gradient_descent(w, eta, grads):
    w -= eta*grads
    return w
```

Accuracy

```
def accuracy(y, y_hat):
    acc = np.sum(y == np.round(y_hat)) / len(y)
    return acc
```

Train

```
X = df1[['x1','x2','x3','x4']].values
y = df1[['y']].values
X, y
```

```
(array([[ 4.9249 ,  0.68906,  0.77344,  1.2095 ],
        [ 4.0948 , -2.9674 ,  2.3689 ,  0.75429],
        [ 2.0153 ,  0.43661,  4.5864 , -0.3151 ],
        ...,
        [-4.9462 ,  3.5716 ,  0.82742, -1.4957 ],
        [-2.588  ,  3.8654 , -0.3336 , -1.2797 ],
        [-3.5741 ,  3.944  , -0.07912, -2.1203 ]]),
 array([[0],
        [0],
        [0],
        ...,
        [1],
        [1],
        [1]]))
```

```
x_train, x_test, y_train, y_test = train_test_split(X, y, test_size=0.2,random_state=42)
```

```
x_train.shape, x_test.shape, y_train.shape, y_test.shape
```

```
((976, 4), (244, 4), (976, 1), (244, 1))
```

```
y_hat = logistic_regression(x_train, np.random.randn(4, 1))
print(y_hat.shape)
```

```
(976, 1)
```

```
x_train = np.hstack((np.ones((len(x_train), 1)), x_train))
x_train.shape
```

```
(976, 5)
```

```
m = 4
w = np.random.randn(m+1, 1)
print(w.shape)
```

```
(5, 1)
```

```
eta = 0.01
n_epochs = 60000 #N
```

```
error_hist = []

for epoch in range(n_epochs):
    # predictions
    y_hat = logistic_regression(x_train, w)

    # loss
    e = bce(y_train, y_hat)
    error_hist.append(e)

    # gradients
    grads = gradient(x_train, y_train, y_hat)

    # gradient descent
    w = gradient_descent(w, eta, grads)

    if (epoch+1) %  1== 0:
        print(f'Epoch={epoch}, \t E={e:.4},\t w={w.T[0]}')
```

```
 Epoch=59942,     E=0.01938,      w=[ 4.00398546 -3.4662217  -2.02849042 -2.46122729 -0.1578695 ]
 Epoch=59943,     E=0.01938,      w=[ 4.00400029 -3.46623788 -2.02849892 -2.46123841 -0.15787025]
 Epoch=59944,     E=0.01938,      w=[ 4.00401513 -3.46625406 -2.02850742 -2.46124953 -0.15787099]
 Epoch=59945,     E=0.01938,      w=[ 4.00402996 -3.46627023 -2.02851593 -2.46126065 -0.15787174]
 Epoch=59946,     E=0.01938,      w=[ 4.0040448  -3.46628641 -2.02852443 -2.46127177 -0.15787248]
 Epoch=59947,     E=0.01938,      w=[ 4.00405963 -3.46630259 -2.02853294 -2.46128289 -0.15787323]
 Epoch=59948,     E=0.01938,      w=[ 4.00407447 -3.46631877 -2.02854144 -2.461294   -0.15787397]
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 Epoch=59997,     E=0.01938,      w=[ 4.0048011  -3.46711125 -2.02895799 -2.46183861 -0.15791047]
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 Epoch=59999,     E=0.01938,      w=[ 4.00483075 -3.46714358 -2.02897499 -2.46186083 -0.15791196]
```
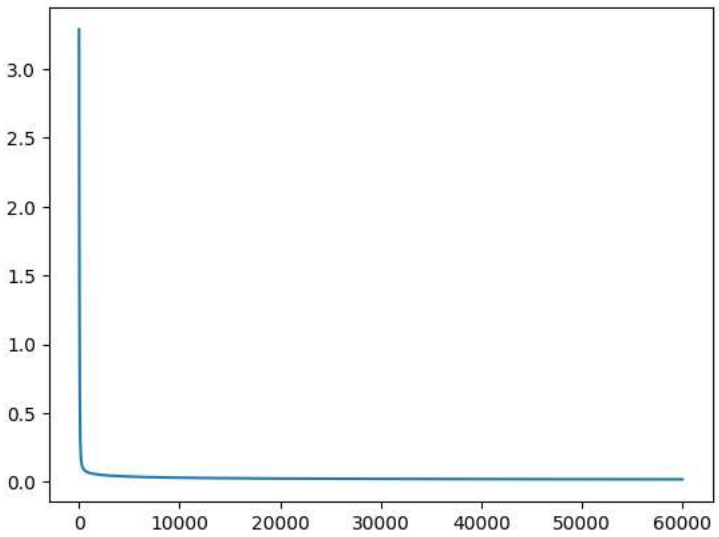

```
plt.plot(error_hist)
```

```
[<matplotlib.lines.Line2D at 0x791b1bfd9840>]
```




```
y_hat = logistic_regression(x_train, w)
accuracy(y_train, y_hat)
```

```
0.9938524590163934
```

```
x_test = np.hstack((np.ones((len(x_test), 1)), x_test))
y_hat = logistic_regression(x_test, w)
accuracy(y_test, y_hat)
```

```
0.9877049180327869
```