```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.datasets import make_blobs
from sklearn.model_selection import train_test_split
import seaborn as sns
sns.set()
```

```
# Step-1 Generate Toy(Dummy) Dataset

X, y = make_blobs(n_samples=2000, n_features=2, cluster_std = 3, centers = 2, random_state=42)
n_features=2
print(X.shape,y.shape)
```

```
(2000, 2) (2000,)
```

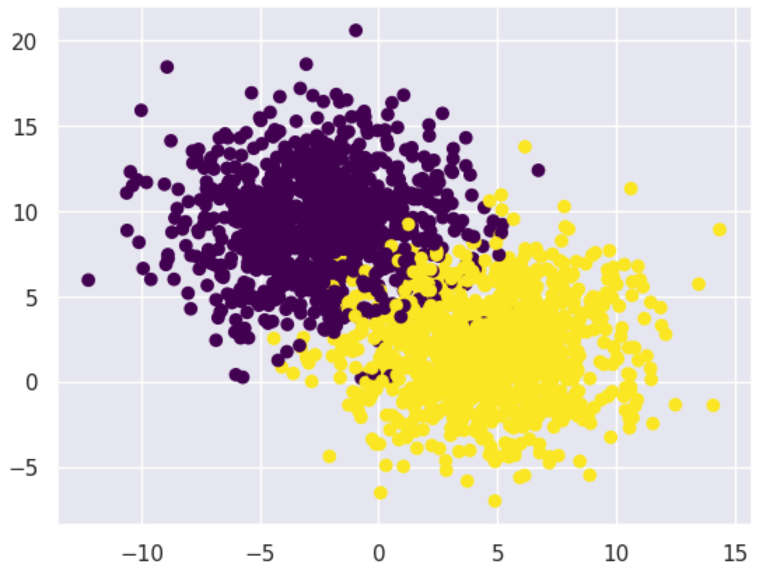
```
print(y)
```

```
[0 0 0 ... 1 0 1]
```

```
# Step - 2 Visualise Dataset
def visualise(X,y):
    plt.scatter(X[:,0],X[:,1],c=y,cmap="viridis")
    plt.show()

```

```
visualise(X,y)
```



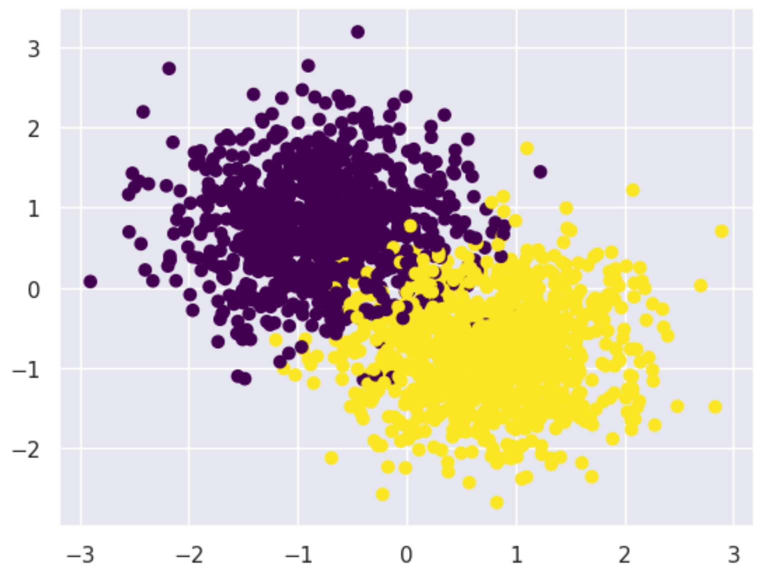
```
# Step - 3
def normalise(X):
    u = X.mean(axis=0)
    std = X.std(axis=0)

    return (X-u)/std

```

```
X = normalise(X)
```

```
visualise(X,y)
```

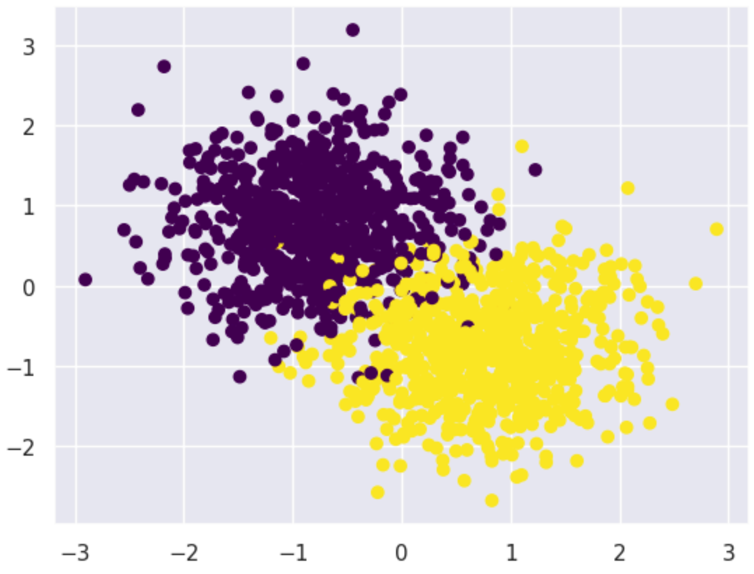


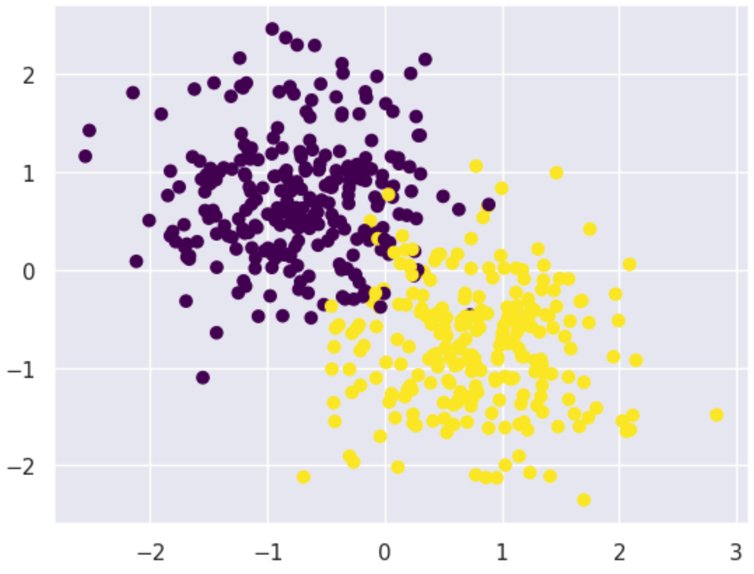
```
# Step - 4 Train Test Split
XT, Xt, yT, yt = train_test_split(X,y, test_size=0.25, shuffle=False, random_state=0)

print(XT.shape, yT.shape)
print(Xt.shape, yt.shape)
```

```
(1500, 2) (1500,)
(500, 2) (500,)
```

```
visualise(XT,yT)
visualise(Xt,yt)
```





```python
# Model
def sigmoid(z):
    return 1/(1 + np.exp(-z))

def hypothesis(X,theta):
    return sigmoid(np.dot(X,theta))

# Binary Cross Entropy
def error(y,yp):
    loss = -np.mean(y*np.log(yp) + (1-y)*np.log(1-yp))
    return loss

def gradient(X,y,yp):
    m = X.shape[0]
    grad = -(1/m)*np.dot(X.T, (y-yp))
    return grad

def train(X,y,max_iters=100,learning_rate=0.1):

    # Randomly init theta
    theta = np.random.randn(n_features + 1,1)

    error_list = []

    for i in range(max_iters):
        yp = hypothesis(X,theta)
        e = error(y,yp)
        error_list.append(e)
        grad = gradient(X,y,yp)
        theta = theta - learning_rate*grad

    plt.plot(error_list)
    return theta

def predict(X,theta):
    h = hypothesis(X,theta)
    preds = np.zeros((X.shape[0],1),dtype='int')
    preds[h >= 0.5] = 1

    return preds

def accuracy(X,y,theta):
    preds = predict(X,theta)
    return ((y==preds).sum())/y.shape[0]*100

```

```
def addExtraColumn(X):
    if X.shape[1] == n_features:
        ones = np.ones((X.shape[0],1))
        X = np.hstack((ones,X))

    return X
```

```
XT = addExtraColumn(XT)
print(XT)
```

```
[[ 1.         -1.43211741  0.65078613]
 [ 1.         -0.47100516  0.87372191]
 [ 1.         -0.40182883  2.1275269 ]
 ...
 [ 1.          0.02390726  0.74454457]
 [ 1.         -0.35936993  0.18771848]
 [ 1.          1.09360417 -1.10077065]]
```

```
Xt = addExtraColumn(Xt)
print(Xt)
```

```
[[ 1.         -1.17860853  1.9119189 ]
 [ 1.          0.70445084 -1.55536144]
 [ 1.          0.39063944 -0.10336496]
 ...
 [ 1.          1.96970601 -0.24632291]
 [ 1.         -0.80805197 -0.01411826]
 [ 1.          0.83964924  0.53655099]]
```

```
print(XT.shape)
```

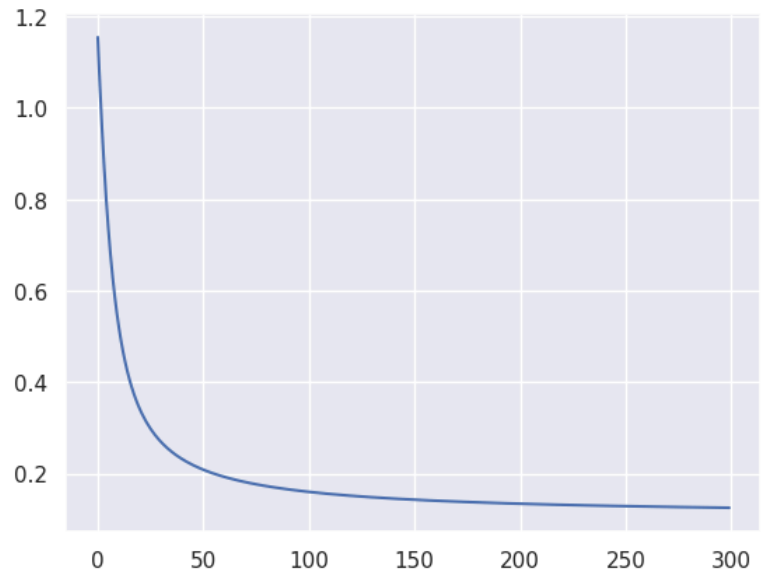
```
(1500, 3)
```

```
yT = yT.reshape(-1,1)
yt = yt.reshape(-1,1)
```

```
print(yT.shape)
print(yt.shape)
```

```
(1500, 1)
(500, 1)
```

```
theta = train(XT,yT,max_iters=300,learning_rate=0.2)
```

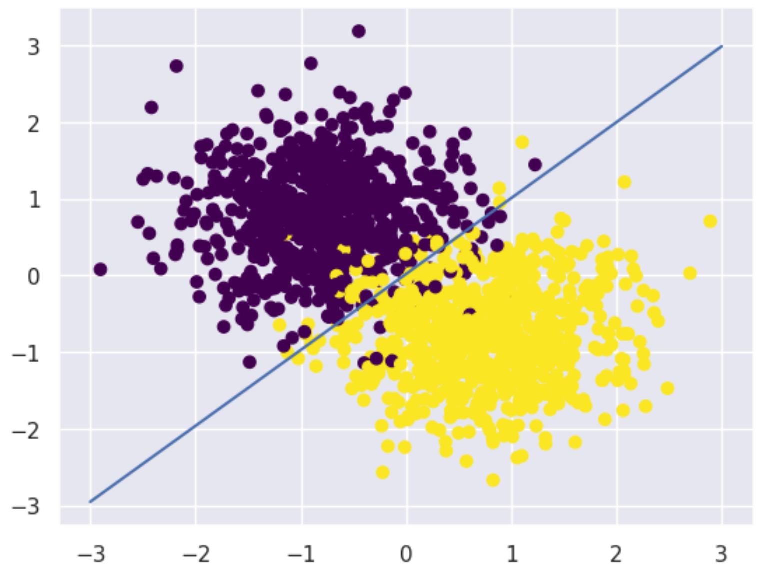


```
theta
```

```
array([[ 0.04566404],
       [ 2.55499585],
       [-2.57913552]])
```

```
# Decision Boundary Visualisation
plt.scatter(XT[:,1],XT[:,2],c=yT,cmap="viridis")

x1 = np.linspace(-3,3,6)
x2 = -(theta[0][0] + theta[1][0]*x1)/theta[2][0]
plt.plot(x1,x2)
plt.show()
```



```
Start coding or generate with AI.
```

```
# Predictions
preds = predict(Xt,theta)
```

```
# Train Accuracy
accuracy(XT,yT,theta)
```

```
np.float64(95.86666666666666)
```

```
# Test Accuracy
accuracy(Xt,yt,theta)
```

```
np.float64(96.2)
```

```
# ------ SkLearn Library -----
```

```
from sklearn.linear_model import LogisticRegression
```

```
# Create
X, y = make_blobs(n_samples=2000, n_features=2, cluster_std = 3, centers = 2, random_state=42)

model = LogisticRegression()
```

```
# Training
model.fit(XT,yT)
```

```
/usr/local/lib/python3.12/dist-packages/sklearn/utils/validation.py:1408: DataConversionWarning: A column-vector y wa
  y = column_or_1d(y, warn=True)
/usr/local/lib/python3.12/dist-packages/sklearn/linear_model/_logistic.py:1256: FutureWarning: 'multi_class' was depr
  warnings.warn(
▾      LogisticRegression
LogisticRegression(multi_class='ovr')
```

```
# Predictions
model.predict(Xt)
```

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

```
# Scoring
model.score(XT,yT)
```

```
0.958
```

```
model.score(Xt,yt)
```

```
0.962
```

```
# ------ Multiclass Classification -----
```

```
X, y = make_blobs(n_samples=2000, n_features=5, cluster_std = 3, centers = 3, random_state=42)
```

```
plt.scatter(X[:,0],X[:,1],c=y,cmap='viridis')
plt.show()
```