22AIE304 Deep Learning

Labsheet 2

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```
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.datasets import load_iris
import matplotlib.pyplot as plt
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report
```

```
class MPNeuron:
    def __init__(self, weights, threshold):
        self.weights = np.array(weights)
        self.threshold = threshold

    def activate(self, inputs):
        weighted_sum = np.dot(inputs, self.weights)

        return 1 if weighted_sum >= self.threshold else 0


def logical_operations():
    and_neuron = MPNeuron(weights=[1, 1], threshold=2)

    or_neuron = MPNeuron(weights=[1, 1], threshold=1)

    nor_neuron = MPNeuron(weights=[-1, -1], threshold=-1)

    inputs = [(0, 0), (0, 1), (1, 0), (1, 1)]

    and_results = [and_neuron.activate(x) for x in inputs]
    or_results = [or_neuron.activate(x) for x in inputs]
    nor_results = [nor_neuron.activate(x) for x in inputs]

    return {"AND": and_results, "OR": or_results, "NOR": nor_results}


if __name__ == "__main__":
    results = logical_operations()
    print("Results:")
    print("AND:", results["AND"])
    print("OR:", results["OR"])
    print("NOR:", results["NOR"])
```

```
Results:
AND: [0, 0, 0, 1]
OR: [0, 1, 1, 1]
NOR: [1, 1, 1, 0]
```

```
from sklearn.datasets import load_breast_cancer

dataset = load_breast_cancer()
X = dataset.data
y = dataset.target
print(X.shape, y.shape)
```

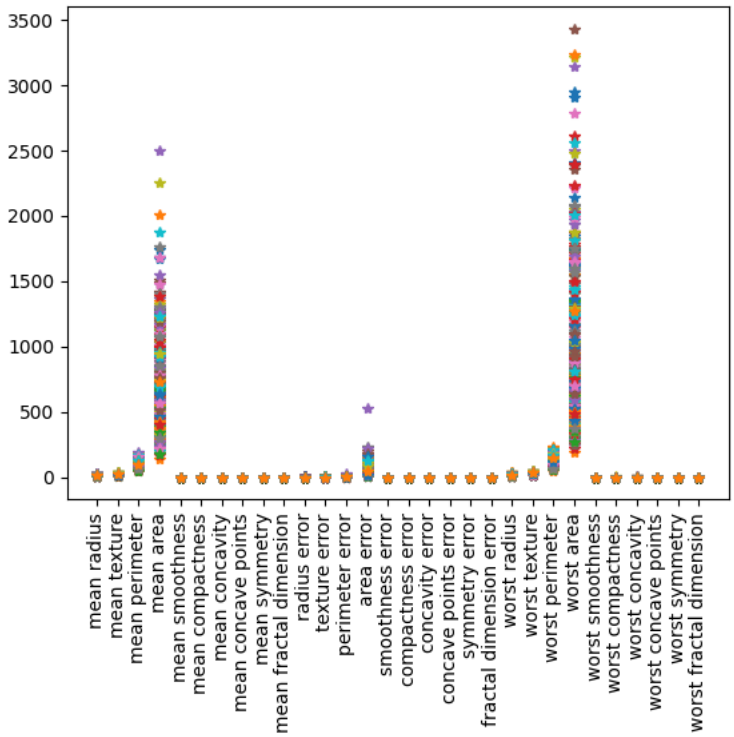
```
(569, 30) (569,)
```

```
data = pd.DataFrame(dataset.data,columns = dataset.feature_names)


data['class'] = dataset.target

X = data.drop('class',axis=1)
y = data['class']
```

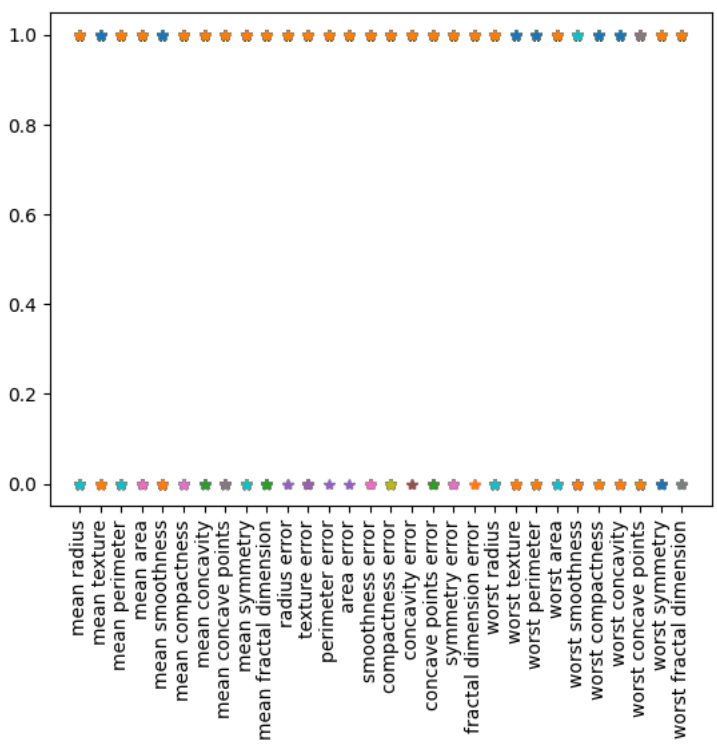
```
X_train,X_test,Y_train,Y_test = train_test_split(X,y,test_size=0.1,stratify=y);
print(X.shape,X_train.shape,X_test.shape)
```

```
(569, 30) (512, 30) (57, 30)
```

```
plt.plot(X_train.T,'*')
plt.xticks(rotation='vertical')
plt.show()
```




```
X_binarised_train = X_train.apply(pd.cut,bins=2,labels=[1,0])
X_binarised_test = X_test.apply(pd.cut,bins=2,labels=[1,0])
plt.plot(X_binarised_train.T,'*')
plt.xticks(rotation='vertical')
plt.show()
```




```
X_binarised_train = X_binarised_train.values
X_binarised_test = X_binarised_test.values
```

```
for b in range(X_binarised_train.shape[1]+1):
  Y_pred_train = []
  accurate_rows = 0
```

```
  for x,y in zip(X_binarised_train,Y_train):
    y_pred = (np.sum(x)>=b)
    Y_pred_train.append(y_pred)
    accurate_rows += (y==y_pred)
  print(b,accurate_rows/X_binarised_train.shape[0])
```

```
0 0.626953125
1 0.626953125
2 0.626953125
3 0.626953125
4 0.626953125
5 0.626953125
6 0.626953125
7 0.626953125
8 0.626953125
9 0.626953125
10 0.626953125
11 0.626953125
12 0.626953125
13 0.630859375
14 0.6328125
15 0.640625
16 0.642578125
17 0.65625
18 0.66015625
19 0.666015625
20 0.677734375
21 0.697265625
22 0.7109375
23 0.74609375
24 0.779296875
25 0.80859375
26 0.845703125
27 0.861328125
28 0.857421875
29 0.826171875
30 0.751953125
```

```
class MPNeuron:
 def __init__(self):
   self.b = None
 def model(self,x):
   return(sum(x)>=self.b)
 def predict(self,X):
   Y=[]
   for x in X:
     result = self.model(x)
     Y.append(result)
   return Y
 def fit(self,X,Y):
   accuracy = {}
   for b in range(X.shape[1]+1):
     self.b = b;
     y_pred = self.predict(X)
     accuracy[b]=accuracy_score(y_pred,Y)
   best_b = max(accuracy,key = accuracy.get)
   self.b = best_b

   print('Optimal value of b is', best_b)
   print('Highest Accuracy is',accuracy[best_b])


mp_neuron = MPNeuron()
mp_neuron.fit(X_binarised_train,Y_train)
```

```
Optimal value of b is 27
Highest Accuracy is 0.861328125
```

```
y_test_pred = mp_neuron.predict(X_binarised_test)
accuracy_test = accuracy_score(y_test_pred,Y_test)
print(accuracy_test)
```

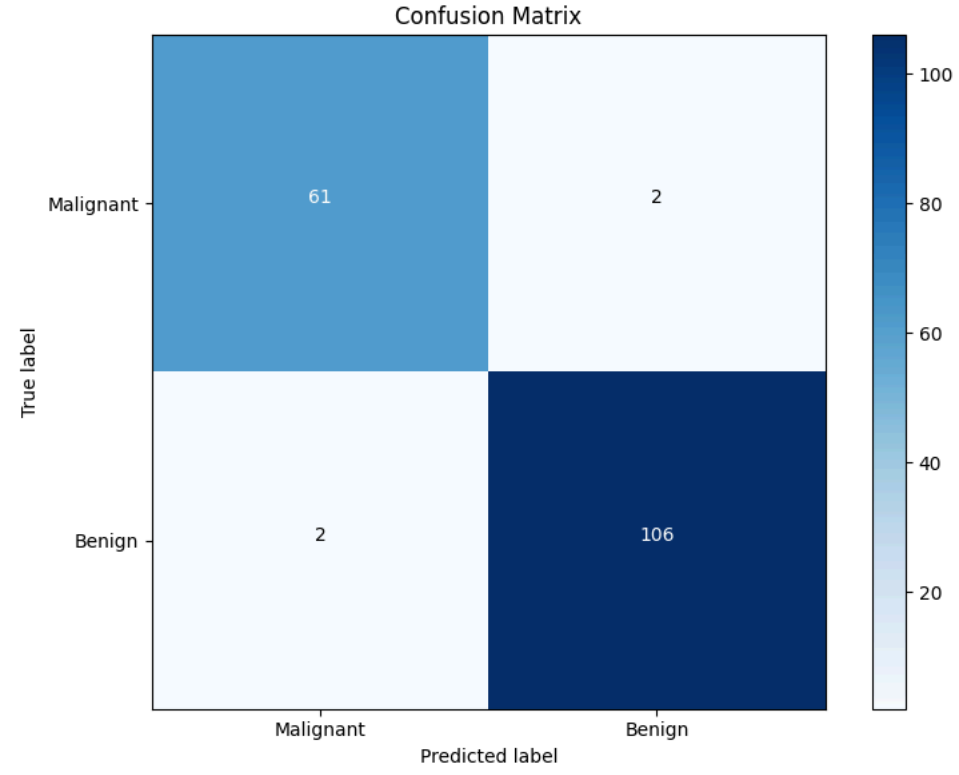
```
0.7894736842105263
```

Now making a logistic regression model to see comparwe performances

```
data = load_breast_cancer()
X = data.data
y = data.target

df = pd.DataFrame(data.data, columns=data.feature_names)
df['target'] = data.target

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)

model = LogisticRegression(max_iter=10000)
```

```
model.fit(X_train, y_train)

y_pred = model.predict(X_test)

accuracy = accuracy_score(y_test, y_pred)
conf_matrix = confusion_matrix(y_test, y_pred)
class_report = classification_report(y_test, y_pred)

print(f'Accuracy: {accuracy:.4f}')
print('Confusion Matrix:')
print(conf_matrix)
print('Classification Report:')
print(class_report)

plt.figure(figsize=(8, 6))
plt.imshow(conf_matrix, interpolation='nearest', cmap=plt.cm.Blues)
plt.title('Confusion Matrix')
plt.colorbar()
tick_marks = np.arange(2)
plt.xticks(tick_marks, ['Malignant', 'Benign'])
plt.yticks(tick_marks, ['Malignant', 'Benign'])

thresh = conf_matrix.max() / 2.
for i, j in np.ndindex(conf_matrix.shape):
    plt.text(j, i, format(conf_matrix[i, j], 'd'),
             horizontalalignment="center",
             color="white" if conf_matrix[i, j] > thresh else "black")

plt.ylabel('True label')
plt.xlabel('Predicted label')
plt.tight_layout()
plt.show()
```

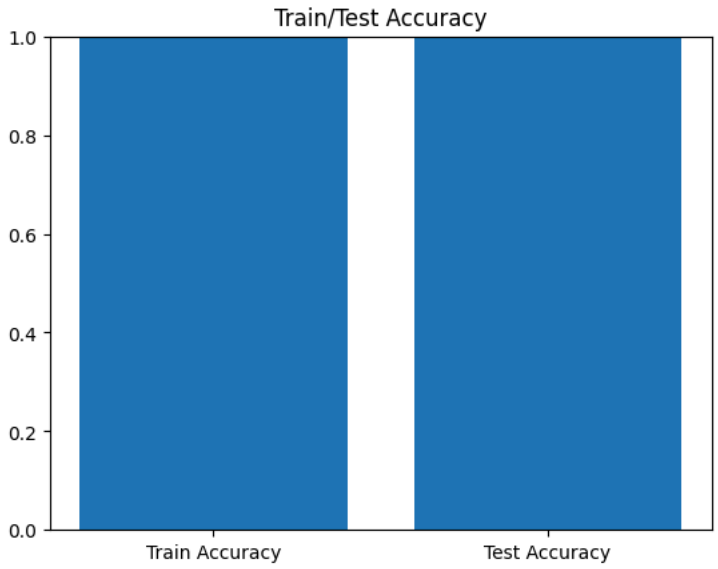
```
Accuracy: 0.9766
Confusion Matrix:
[[ 61   2]
 [  2 106]]
Classification Report:
              precision    recall  f1-score   support

           0       0.97      0.97      0.97        63
           1       0.98      0.98      0.98       108

    accuracy                           0.98       171
   macro avg       0.97      0.97      0.97       171
weighted avg       0.98      0.98      0.98       171
```



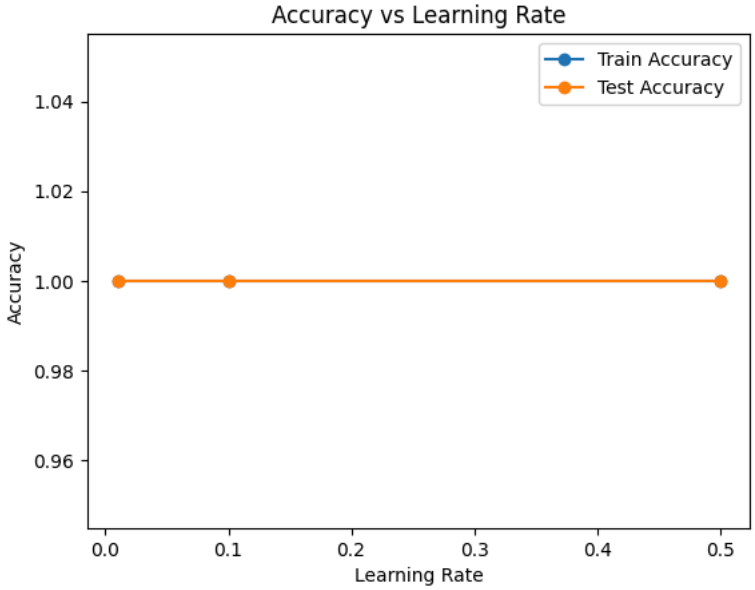
The Logistic Regression has as higher accuracy and better performance in comparison to the Perceptron

Exercise 4

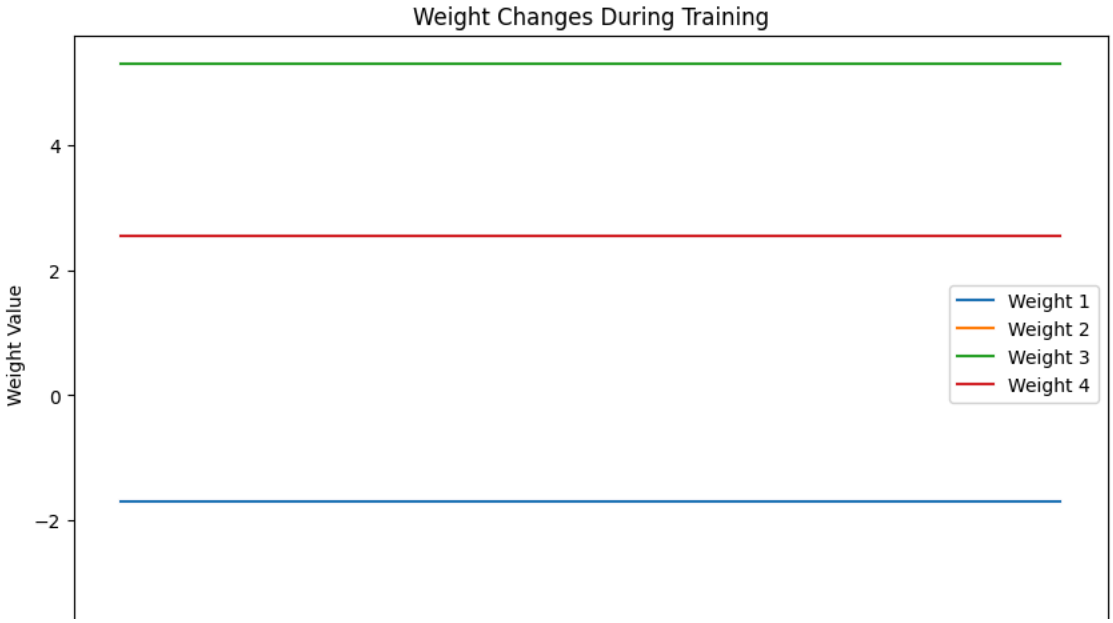
```
iris = load_iris()
data = pd.DataFrame(data=iris.data, columns=iris.feature_names)
data['target'] = iris.target

# Filter to only include Setosa and Versicolor
data = data[data['target'] != 2]

X = data[iris.feature_names]
y = data['target'].replace({0: 0, 1: 1})

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)



class Perceptron:
    def __init__(self, learning_rate=0.01, n_epochs=1000):
        self.learning_rate = learning_rate
        self.n_epochs = n_epochs
        self.weights = None
        self.bias = None

    def fit(self, X, y):
        n_samples, n_features = X.shape
        self.weights = np.zeros(n_features)
        self.bias = 0
        self.weight_matrix = []

        for _ in range(self.n_epochs):
            for idx, x_i in enumerate(X):
                linear_output = np.dot(x_i, self.weights) + self.bias
                y_predicted = self._activation(linear_output)

                update = self.learning_rate * (y[idx] - y_predicted)
                self.weights += update * x_i
                self.bias += update

            self.weight_matrix.append(self.weights.copy())

    def predict(self, X):
        linear_output = np.dot(X, self.weights) + self.bias
        return self._activation(linear_output)

    def _activation(self, x):
        return np.where(x >= 0, 1, 0)



perceptron = Perceptron(learning_rate=0.1, n_epochs=100)
perceptron.fit(X_train.to_numpy(), y_train.to_numpy())

train_accuracy = np.mean(perceptron.predict(X_train.to_numpy()) == y_train.to_numpy())
test_accuracy = np.mean(perceptron.predict(X_test.to_numpy()) == y_test.to_numpy())

plt.bar(['Train Accuracy', 'Test Accuracy'], [train_accuracy, test_accuracy])
plt.ylim(0, 1)
plt.title('Train/Test Accuracy')
plt.show()
```




```
learning_rates = [0.01, 0.1, 0.5]
train_accuracies = []
test_accuracies = []

for lr in learning_rates:
    perceptron = Perceptron(learning_rate=lr, n_epochs=100)
    perceptron.fit(X_train.to_numpy(), y_train.to_numpy())

    train_accuracy = np.mean(perceptron.predict(X_train.to_numpy()) == y_train.to_numpy())
    test_accuracy = np.mean(perceptron.predict(X_test.to_numpy()) == y_test.to_numpy())

    train_accuracies.append(train_accuracy)
    test_accuracies.append(test_accuracy)

plt.plot(learning_rates, train_accuracies, marker='o', label='Train Accuracy')
plt.plot(learning_rates, test_accuracies, marker='o', label='Test Accuracy')
plt.xlabel('Learning Rate')
plt.ylabel('Accuracy')
plt.title('Accuracy vs Learning Rate')
plt.legend()
plt.show()
```




```
weight_matrix = np.array(perceptron.weight_matrix)

plt.figure(figsize=(10, 6))
for i in range(weight_matrix.shape[1]):
    plt.plot(weight_matrix[:, i], label=f'Weight {i + 1}')

plt.xlabel('Epoch')
plt.ylabel('Weight Value')
plt.title('Weight Changes During Training')
plt.legend()
plt.show()
```


Weight Changes During Training
Weight Value
4
2
0
−2
Weight 1
Weight 2
Weight 3
Weight 4