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1 Lab 05 - Task

1.1 Perceptron algorithm to the Iris dataset

2 1. Load the iris dataset using scikit-learn library

[32]:
```
import pandas as pd
from sklearn.datasets import load_iris
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.linear_model import Perceptron
from sklearn.metrics import accuracy_score, precision_score, recall_score,␣
↪f1_score


# Load iris dataset
iris = load_iris()
```

3 2. Create a Pandas DataFrame with the dataset and add column names

[33]:
```
# Create a Pandas DataFrame
df = pd.DataFrame(iris.data, columns=iris.feature_names)

# Add target column to the DataFrame
df['target'] = iris.target

df
```

[33]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	\
0	5.1	3.5	1.4	0.2	
1	4.9	3.0	1.4	0.2	
2	4.7	3.2	1.3	0.2	
3	4.6	3.1	1.5	0.2	
4	5.0	3.6	1.4	0.2	
..	…	…	…	…	

```
145                6.7               3.0                5.2               2.3
146                6.3               2.5                5.0               1.9
147                6.5               3.0                5.2               2.0
148                6.2               3.4                5.4               2.3
149                5.9               3.0                5.1               1.8

     target
0         0
1         0
2         0
3         0
4         0
..      …
145       2
146       2
147       2
148       2
149       2

[150 rows x 5 columns]
```

[34]:
```
df.shape
```

[34]:
```
(150, 5)
```

[35]:
```
df.describe()
```

[35]:
```
       sepal length (cm)  sepal width (cm)  petal length (cm)  \
count         150.000000        150.000000         150.000000
mean            5.843333          3.057333           3.758000
std             0.828066          0.435866           1.765298
min             4.300000          2.000000           1.000000
25%             5.100000          2.800000           1.600000
50%             5.800000          3.000000           4.350000
75%             6.400000          3.300000           5.100000
max             7.900000          4.400000           6.900000

       petal width (cm)      target
count        150.000000  150.000000
mean           1.199333    1.000000
std            0.762238    0.819232
min            0.100000    0.000000
25%            0.300000    0.000000
50%            1.300000    1.000000
75%            1.800000    2.000000
max            2.500000    2.000000
```

[36]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150 entries, 0 to 149
Data columns (total 5 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   sepal length (cm)  150 non-null    float64
 1   sepal width (cm)   150 non-null    float64
 2   petal length (cm)  150 non-null    float64
 3   petal width (cm)   150 non-null    float64
 4   target             150 non-null    int64  
dtypes: float64(4), int64(1)
memory usage: 6.0 KB
```

4 3. Convert the problem into a binary classification problem by only considering two classes and removing the third one. For example, we can keep only "setosa" and "versicolor" classes and remove "virginica".

[38]:
```
# Keep only "setosa" and "versicolor" classes
df = df[df['target'] != 2]
```

[39]:
```
df
```

[39]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	target
0	5.1	3.5	1.4	0.2	0
1	4.9	3.0	1.4	0.2	0
2	4.7	3.2	1.3	0.2	0
3	4.6	3.1	1.5	0.2	0
4	5.0	3.6	1.4	0.2	0
..	…	…	…	…	…
95	5.7	3.0	4.2	1.2	
96	5.7	2.9	4.2	1.3	
97	6.2	2.9	4.3	1.3	
98	5.1	2.5	3.0	1.1	
99	5.7	2.8	4.1	1.3	

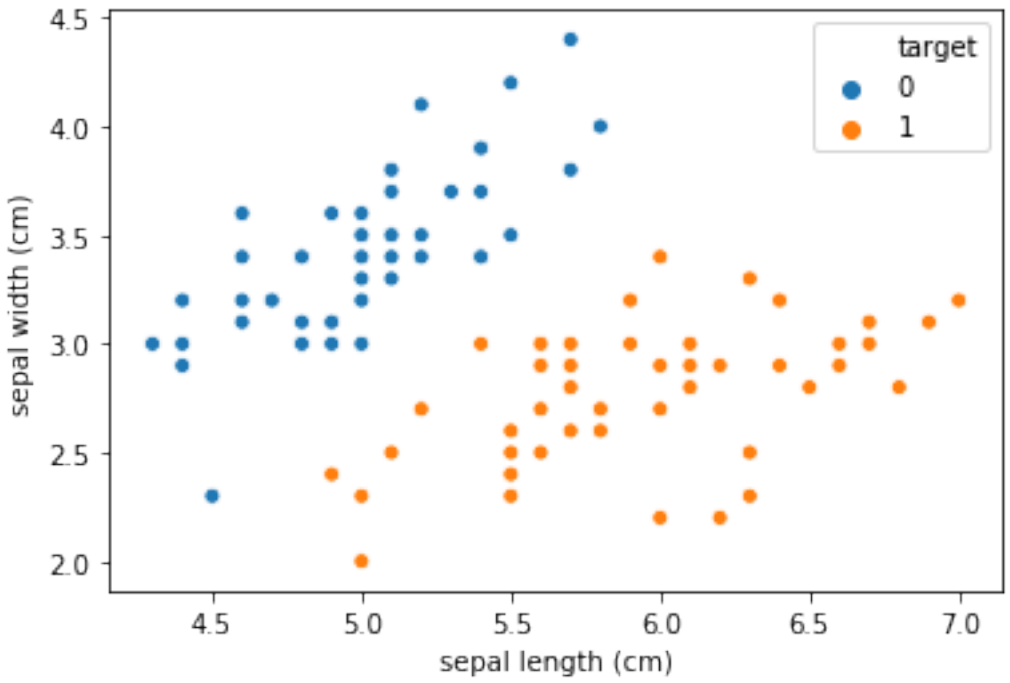
```
95       1
96       1
97       1
98       1
99       1

[100 rows x 5 columns]
```

5 Visualize the data using scatter plot

[40]:
```
# Create a scatter plot
sns.scatterplot(data=df, x='sepal length (cm)', y='sepal width (cm)',␣
↪hue='target')

# Show the plot
import matplotlib.pyplot as plt
plt.show()
```



6 Split the data into train and test sets

[41]:
```
X_train, X_test, y_train, y_test = train_test_split(df[iris.feature_names],␣
↪df['target'], test_size=0.2, random_state=42)
```

[42]:
```
X_train
```

[42]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)
55	5.7	2.8	4.5	1.3
88	5.6	3.0	4.1	1.3
26	5.0	3.4	1.6	0.4
42	4.4	3.2	1.3	0.2
69	5.6	2.5	3.9	1.1
..	…	…	…	…
60	5.0	2.0	3.5	1.0
71	6.1	2.8	4.0	1.3
14	5.8	4.0	1.2	0.2
92	5.8	2.6	4.0	1.2
51	6.4	3.2	4.5	1.5

[80 rows x 4 columns]

[43]:
```
X_train.shape
```

[43]:
```
(80, 4)
```

[44]:
```
X_test
```

[44]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)
83	6.0	2.7	5.1	1.6
53	5.5	2.3	4.0	1.3
70	5.9	3.2	4.8	1.8
45	4.8	3.0	1.4	0.3
44	5.1	3.8	1.9	0.4
39	5.1	3.4	1.5	0.2
22	4.6	3.6	1.0	0.2
80	5.5	2.4	3.8	1.1
10	5.4	3.7	1.5	0.2
0	5.1	3.5	1.4	0.2
18	5.7	3.8	1.7	0.3
30	4.8	3.1	1.6	0.2
73	6.1	2.8	4.7	1.2
33	5.5	4.2	1.4	0.2
90	5.5	2.6	4.4	1.2
4	5.0	3.6	1.4	0.2
76	6.8	2.8	4.8	1.4
77	6.7	3.0	5.0	1.7

```
12                4.8               3.0               1.4               0.1
31                5.4               3.4               1.5               0.4
```

[45]:
```
X_test.shape
```

[45]:
```
(20, 4)
```

[46]:
```
y_train
```

[46]:
```
55    1
88    1
26    0
42    0
69    1
     ..
60    1
71    1
14    0
92    1
51    1
Name: target, Length: 80, dtype: int64
```

[47]:
```
y_train.shape
```

[47]:
```
(80,)
```

[48]:
```
y_test
```

[48]:
```
83    1
53    1
70    1
45    0
44    0
39    0
22    0
80    1
10    0
0     0
18    0
30    0
73    1
33    0
90    1
4     0
76    1
77    1
12    0
```

```
31    0
Name: target, dtype: int64
```

[49]:
```
y_test.shape
```

[49]:
```
(20,)
```

7 6. Apply the built-in Perceptron algorithm from scikit-learn

[50]:
```
# Create an instance of the Perceptron algorithm
perceptron = Perceptron()

# Fit the model on the training data
perceptron.fit(X_train, y_train)
```

[50]:
```
Perceptron(alpha=0.0001, class_weight=None, early_stopping=False, eta0=1.0,
           fit_intercept=True, max_iter=1000, n_iter_no_change=5, n_jobs=None,
           penalty=None, random_state=0, shuffle=True, tol=0.001,
           validation_fraction=0.1, verbose=0, warm_start=False)
```

8 Evaluate the accuracy, precision, recall, and F1 score of the model.

[51]:
```
# Make predictions on the test data
y_pred = perceptron.predict(X_test)

# Calculate the evaluation metrics
accuracy = accuracy_score(y_test, y_pred)
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)

# Print the evaluation metrics
print('Accuracy:', accuracy)
print('Precision:', precision)
print('Recall:', recall)
print('F1 score:', f1)
```

```
Accuracy: 1.0
Precision: 1.0
Recall: 1.0
F1 score: 1.0
```

9 Apply the Perceptron algorithm from scratch using above code snippets

[52]:
```
def train_weights(train, l_rate, n_epoch):

    weights = [0.0 for i in range(len(train[0]))]

    for epoch in range(n_epoch):

        sum_error = 0.0

        for row in train:

            prediction = predict(row, weights)

            error = row[-1] - prediction

            sum_error += error**2

            weights[0] = weights[0] + l_rate * error  #bias(t+1) = bias(t) +␣
↪learning_rate * (expected(t) - predicted(t))

            for i in range(len(row)-1):

                weights[i + 1] = weights[i + 1] + l_rate * error * row[i]␣
↪#w(t+1) = w(t) + learning_rate * (expected(t) - predicted(t)) * x(t)

        print('epoch=%d, lrate=%.3f, error=%.3f' % (epoch, l_rate, sum_error))

    return weights
```

[53]:
```
def predict(row, weights):
#     bias value at weights[0]
    activation = weights[0]
    for i in range(len(row)-1):
        activation += weights[i + 1] * row[i]
    return 1.0 if activation >= 0.0 else 0.0
```

[ ]:
```

```

10 Apply the Perceptron algorithm from scratch using above code snippets

[54]:
```
# Define the learning rate and number of epochs
l_rate = 0.01
n_epoch = 50

# Train the model on the training data
weights = train_weights(X_train.values, l_rate, n_epoch)

# Make predictions on the test data
y_pred = [predict(row, weights) for row in X_test.values]

# Calculate the evaluation metrics
accuracy = accuracy_score(y_test, y_pred)
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)
```

```
epoch=0, lrate=0.010, error=23.580
epoch=1, lrate=0.010, error=20.380
epoch=2, lrate=0.010, error=20.780
epoch=3, lrate=0.010, error=20.780
epoch=4, lrate=0.010, error=20.180
epoch=5, lrate=0.010, error=20.380
epoch=6, lrate=0.010, error=21.380
epoch=7, lrate=0.010, error=20.780
epoch=8, lrate=0.010, error=20.780
epoch=9, lrate=0.010, error=21.380
epoch=10, lrate=0.010, error=20.580
epoch=11, lrate=0.010, error=20.580
epoch=12, lrate=0.010, error=21.180
epoch=13, lrate=0.010, error=21.180
epoch=14, lrate=0.010, error=20.780
epoch=15, lrate=0.010, error=20.580
epoch=16, lrate=0.010, error=21.180
epoch=17, lrate=0.010, error=20.780
epoch=18, lrate=0.010, error=21.180
epoch=19, lrate=0.010, error=20.780
epoch=20, lrate=0.010, error=21.380
epoch=21, lrate=0.010, error=20.780
epoch=22, lrate=0.010, error=20.780
epoch=23, lrate=0.010, error=21.380
epoch=24, lrate=0.010, error=20.780
epoch=25, lrate=0.010, error=21.380
epoch=26, lrate=0.010, error=20.780
epoch=27, lrate=0.010, error=21.380
```

```
epoch=28, lrate=0.010, error=20.780
epoch=29, lrate=0.010, error=20.780
epoch=30, lrate=0.010, error=21.380
epoch=31, lrate=0.010, error=20.780
epoch=32, lrate=0.010, error=21.380
epoch=33, lrate=0.010, error=20.780
epoch=34, lrate=0.010, error=21.380
epoch=35, lrate=0.010, error=20.580
epoch=36, lrate=0.010, error=20.780
epoch=37, lrate=0.010, error=21.180
epoch=38, lrate=0.010, error=20.780
epoch=39, lrate=0.010, error=21.180
epoch=40, lrate=0.010, error=20.780
epoch=41, lrate=0.010, error=21.180
epoch=42, lrate=0.010, error=21.380
epoch=43, lrate=0.010, error=20.580
epoch=44, lrate=0.010, error=21.180
epoch=45, lrate=0.010, error=20.580
epoch=46, lrate=0.010, error=21.180
epoch=47, lrate=0.010, error=20.580
epoch=48, lrate=0.010, error=21.180
epoch=49, lrate=0.010, error=20.580
```

11 9. Evaluate the accuracy, precision, recall, and F1 score of the model.

[55]:
```
# Print the evaluation metrics
print('Accuracy:', accuracy)
print('Precision:', precision)
print('Recall:', recall)
print('F1 score:', f1)
```

```
Accuracy: 0.55
Precision: 0.47058823529411764
Recall: 1.0
F1 score: 0.6399999999999999
```