Problem 1. Linear Discriminant Analysis

Importing Libraries

In [77]:

```
import numpy as np
import pandas as pd
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
import matplotlib.pyplot as plt
```

Reading the dataset

In [78]:

```
dataset = pd.read_csv('/Users/dakshbhuva/Downloads/Iris.csv')
dataset.head()
```

Out[78]:

	Id	SepalLengthCm	SepalWidthCm	PetalLengthCm	PetalWidthCm	Species
0	1	5.1	3.5	1.4	0.2	Iris-setosa
1	2	4.9	3.0	1.4	0.2	Iris-setosa
2	3	4.7	3.2	1.3	0.2	Iris-setosa
3	4	4.6	3.1	1.5	0.2	Iris-setosa
4	5	5.0	3.6	1.4	0.2	Iris-setosa

Extracting only required columns

In [79]:

```
cols_to_use = ['SepalLengthCm','SepalWidthCm','PetalLengthCm','PetalWidthCm',
dataset = dataset[cols_to_use]
dataset
```

Out[79]:

	SepalLengthCm	SepalWidthCm	PetalLengthCm	PetalWidthCm	Species
0	5.1	3.5	1.4	0.2	Iris-setosa
1	4.9	3.0	1.4	0.2	Iris-setosa
2	4.7	3.2	1.3	0.2	Iris-setosa
3	4.6	3.1	1.5	0.2	Iris-setosa
4	5.0	3.6	1.4	0.2	Iris-setosa
...	...	...	...	...	...
145	6.7	3.0	5.2	2.3	Iris-virginica
146	6.3	2.5	5.0	1.9	Iris-virginica
147	6.5	3.0	5.2	2.0	Iris-virginica
148	6.2	3.4	5.4	2.3	Iris-virginica
149	5.9	3.0	5.1	1.8	Iris-virginica

150 rows × 5 columns

X is the 4 features of the dataset and y is output 'species'

In [80]:

```
dvalues = dataset.values
X, y = dvalues[:, :-1], dvalues[:, -1]
print(X)
print(y)
```

```
[[5.1 3.5 1.4 0.2]
 [4.9 3.0 1.4 0.2]
 [4.7 3.2 1.3 0.2]
 [4.6 3.1 1.5 0.2]
 [5.0 3.6 1.4 0.2]
 [5.4 3.9 1.7 0.4]
 [4.6 3.4 1.4 0.3]
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 [5.4 3.7 1.5 0.2]
 [4.8 3.4 1.6 0.2]
 [4.8 3.0 1.4 0.1]
 [4.3 3.0 1.1 0.1]
 [5.8 4.0 1.2 0.2]
 [5.7 4.4 1.5 0.4]
 [5.4 3.9 1.3 0.4]
 [5.1 3.5 1.4 0.3]
 [5.7 3.8 1.7 0.3]
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 [5.2 3.4 1.4 0.2]
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 [4.9 3.1 1.5 0.1]
 [5.0 3.2 1.2 0.2]
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 [7.0 3.2 4.7 1.4]
 [6.4 3.2 4.5 1.5]
 [6.9 3.1 4.9 1.5]
 [5.5 2.3 4.0 1.3]
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 [6.1 2.8 4.7 1.2]
 [6.4 2.9 4.3 1.3]
 [6.6 3.0 4.4 1.4]
 [6.8 2.8 4.8 1.4]
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[6.7 3.0 5.0 1.7]
[6.0 2.9 4.5 1.5]
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[6.0 2.7 5.1 1.6]
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[6.0 3.4 4.5 1.6]
[6.7 3.1 4.7 1.5]
[6.3 2.3 4.4 1.3]
[5.6 3.0 4.1 1.3]
[5.5 2.5 4.0 1.3]
[5.5 2.6 4.4 1.2]
[6.1 3.0 4.6 1.4]
[5.8 2.6 4.0 1.2]
[5.0 2.3 3.3 1.0]
[5.6 2.7 4.2 1.3]
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[6.2 2.9 4.3 1.3]
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[6.3 2.9 5.6 1.8]
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[7.6 3.0 6.6 2.1]
[4.9 2.5 4.5 1.7]
[7.3 2.9 6.3 1.8]
[6.7 2.5 5.8 1.8]
[7.2 3.6 6.1 2.5]
[6.5 3.2 5.1 2.0]
[6.4 2.7 5.3 1.9]
[6.8 3.0 5.5 2.1]
[5.7 2.5 5.0 2.0]
[5.8 2.8 5.1 2.4]
[6.4 3.2 5.3 2.3]
[6.5 3.0 5.5 1.8]
[7.7 3.8 6.7 2.2]
[7.7 2.6 6.9 2.3]
[6.0 2.2 5.0 1.5]
[6.9 3.2 5.7 2.3]
[5.6 2.8 4.9 2.0]
[7.7 2.8 6.7 2.0]
[6.3 2.7 4.9 1.8]
[6.7 3.3 5.7 2.1]
[7.2 3.2 6.0 1.8]
[6.2 2.8 4.8 1.8]
[6.1 3.0 4.9 1.8]
[6.4 2.8 5.6 2.1]
[7.2 3.0 5.8 1.6]
[7.4 2.8 6.1 1.9]
[7.9 3.8 6.4 2.0]
[6.4 2.8 5.6 2.2]
[6.3 2.8 5.1 1.5]
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 [6.1 2.6 5.6 1.4]
 [7.7 3.0 6.1 2.3]
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 [6.4 3.1 5.5 1.8]
 [6.0 3.0 4.8 1.8]
 [6.9 3.1 5.4 2.1]
 [6.7 3.1 5.6 2.4]
 [6.9 3.1 5.1 2.3]
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 [6.8 3.2 5.9 2.3]
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 [6.7 3.0 5.2 2.3]
 [6.3 2.5 5.0 1.9]
 [6.5 3.0 5.2 2.0]
 [6.2 3.4 5.4 2.3]
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['Iris-setosa' 'Iris-setosa' 'Iris-setosa' 'Iris-setosa' 'Iris-setosa'
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 'Iris-virginica' 'Iris-virginica' 'Iris-virginica' 'Iris-virginica'
 'Iris-virginica' 'Iris-virginica' 'Iris-virginica' 'Iris-virginica'
 'Iris-virginica' 'Iris-virginica' 'Iris-virginica' 'Iris-virginica']
```
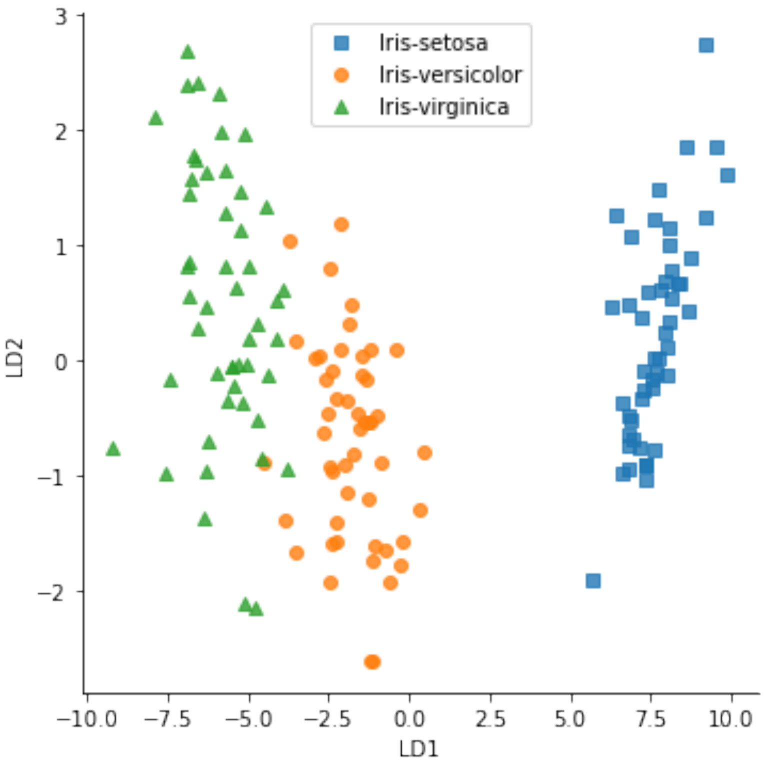

Implementing LDA on whole dataset

In [81]:

```
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis

LDA = LinearDiscriminantAnalysis(n_components = 2)
# fitting the LDA model where X are the features of the Iris Dataset and y is
X_values = LDA.fit(X,y)
# By tranforming, from LinearDiscriminantAnalysis we get LD1 and LD2
X_values = X_values.transform(X)
#print(X_values)
# making new dataframe with LD1, LD2 and output 'species'
LDA_new = pd.DataFrame(X_values)
LDA_new['species'] = y
#print(LDA_new)
LDA_new.columns=["LD1","LD2","species"]
# plotting LD1 vs LD2
markers = ['s', 'o', '^']
sns.lmplot(x="LD1", y="LD2", data = LDA_new, hue = 'species', markers = marke
plt.legend(loc='upper center')
plt.show()
```



Now implementing LDA for each pair of the classes

Making pairs of the given 3 types of species

In [82]:

```
class_names = dataset['Species'].unique()

grouped = dataset.groupby('Species')

# s1,s2,s3 contain datasets of class types 1,2,3 respectively
s1 = grouped.get_group(class_names[0])
s2 = grouped.get_group(class_names[1])
s3 = grouped.get_group(class_names[2])

# pairing datasets to perform LDA pairwise
first_and_second = s1.append(s2)
second_and_third = s2.append(s3)
first_and_third = s1.append(s3)
```

Importing the LDA model

In [83]:

```
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis

LDA= LinearDiscriminantAnalysis(n_components = 1)
```

For species 1 and 2:

X is the 4 features of the dataset and y is output 'species'

In [84]:

```
X = first_and_second[first_and_second.columns[0:4]]
y = first_and_second[first_and_second.columns[4]]
```

Training, Testing and Accuracy of the model

In [85]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, ran

LDA.fit(X_train, y_train)
y_pred = LDA.predict(X_test)
print('Accuracy score:')
accuracy_score(y_test,y_pred)
```

```
Accuracy score:
```

Out[85]:

```
1.0
```

For species 2 and 3:

X is the 4 features of the dataset and y is output 'species'

In [86]:

```
X = second_and_third[second_and_third.columns[0:4]]
y = second_and_third[second_and_third.columns[4]]
```

Training, Testing and Accuracy of the model

In [87]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, ran

LDA.fit(X_train, y_train)
y_pred = LDA.predict(X_test)
print('Accuracy score:')
accuracy_score(y_test,y_pred)
```

```
Accuracy score:
```

Out[87]:

```
0.92
```

For species 1 and 3:

X is the 4 features of the dataset and y is output 'species'

In [88]:

```
X = first_and_third[first_and_third.columns[0:4]]
y = first_and_third[first_and_third.columns[4]]
```

Training, Testing and Accuracy of the model

In [89]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, ran

LDA.fit(X_train, y_train)
y_pred = LDA.predict(X_test)
print('Accuracy score:')
accuracy_score(y_test,y_pred)
```

```
Accuracy score:
```

Out[89]:

```
1.0
```