```
import sklearn
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
```

```
/usr/local/lib/python3.6/dist-packages/statsmodels/tools/_testing.py:19: FutureWarnin
  import pandas.util.testing as tm
```

```
from sklearn.datasets import load_iris
iris = load_iris()
y1=iris.target
x1= iris.data
```

```
df = pd.DataFrame(x1,
                  columns = iris.feature_names)
```

```
x1
```

```
df['species']=y1
```

```
df['petal width (cm)'].unique().tolist()
```

```
[0.2,
 0.4,
 0.3,
 0.1,
 0.5,
 0.6,
 1.4,
 1.5,
 1.3,
 1.6,
 1.0,
 1.1,
 1.8,
 1.2,
 1.7,
 2.5,
 1.9,
 2.1,
 2.2,
 2.0,
 2.4,
 2.3]
```

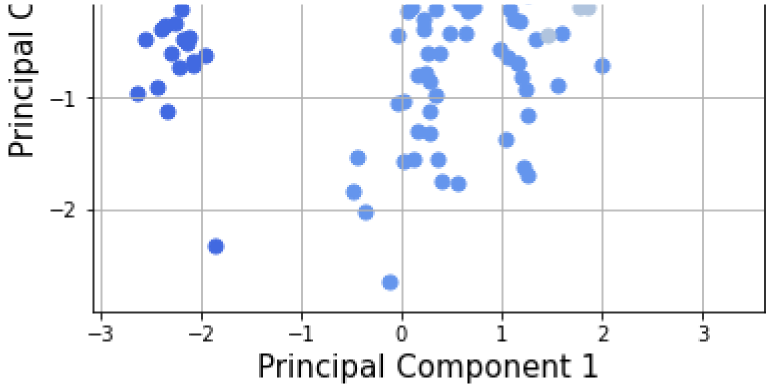
```
def categorize(x):
    if x < 4:
        return 0
```

```
    elif x>=4 and x<=5.5:
        return 1
    else:
        return 2
def categorize2(x):
    if x < 5:
        return 0
    elif x>=5 and x<=6:
        return 1
    else:
        return 2
def categorize3(x):
    if x < 3:
        return 0
    elif x>=3 and x<=4:
        return 1
    else:
        return 2
def categorize4(x):
    if x < 1:
        return 0
    elif x>=1 and x<=2:
        return 1
    else:
        return 2
df['petal length cat']= 0
for i in range(150):
  df['petal length cat'][i]= categorize(df['petal length (cm)'][i])
df['petal width cat']= 0
for i in range(150):
  df['petal width cat'][i]= categorize4(df['petal width (cm)'][i])
df['sepal length cat']= 0
for i in range(150):
  df['sepal length cat'][i]= categorize2(df['sepal length (cm)'][i])
df['sepal width cat']= 0
for i in range(150):
  df['sepal width cat'][i]= categorize3(df['sepal width (cm)'][i])
df
```

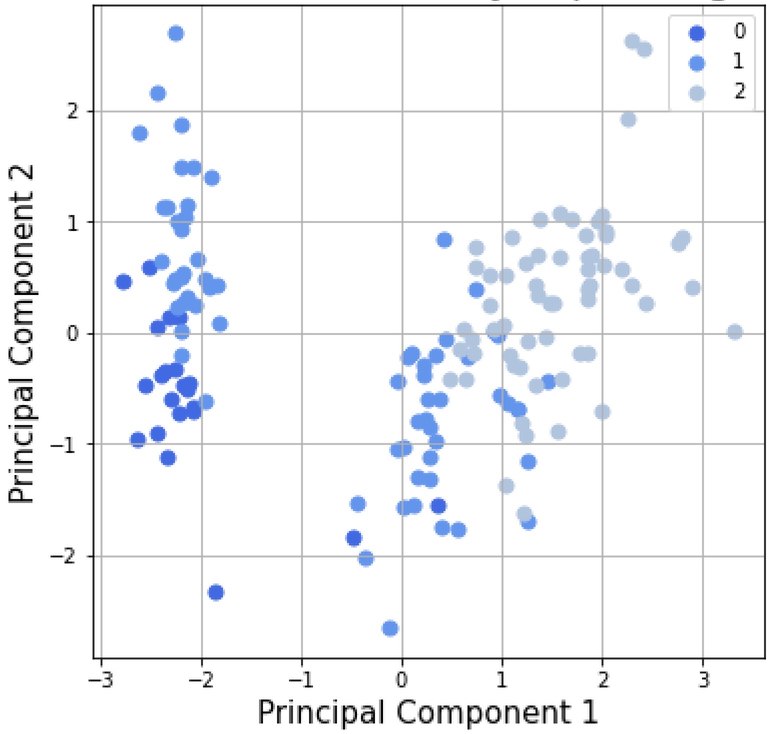
```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:31: SettingWithCopyWarni
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:34: SettingWithCopyWarni
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:37: SettingWithCopyWarni
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:40: SettingWithCopyWarni
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
```

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	specie
0	5.1	3.5	1.4	0.2	
1	4.9	3.0	1.4	0.2	

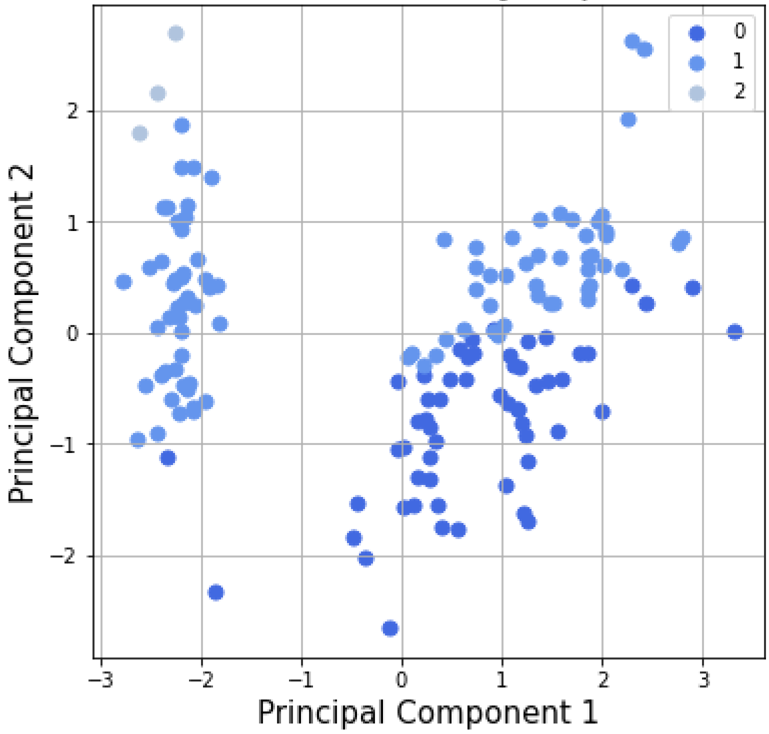
```
from sklearn.preprocessing import StandardScaler
# Standardizing the features
x = StandardScaler().fit_transform(x1)
#principal component analysis
from sklearn.decomposition import PCA
pca = PCA(n_components=2)
principalComponents = pca.fit_transform(x)
principalDf = pd.DataFrame(data = principalComponents
             , columns = ['principal component 1', 'principal component 2'])

for i in ['petal length cat','petal width cat','sepal length cat','sepal width cat']:
  finalDf = pd.concat([principalDf, df[[i]]], axis = 1)
  fig = plt.figure(figsize = (6,6))
  ax = fig.add_subplot(1,1,1)
  ax.set_xlabel('Principal Component 1', fontsize = 15)
  ax.set_ylabel('Principal Component 2', fontsize = 15)
  ax.set_title('PCA characterized by {0}'.format(i[:-4]), fontsize = 20)
  targets = [0, 1, 2]
  colors = ['royalblue', 'cornflowerblue', 'lightsteelblue']
  for target, color in zip(targets,colors):
      indicesToKeep = finalDf[i] == target
      ax.scatter(finalDf.loc[indicesToKeep, 'principal component 1']
               , finalDf.loc[indicesToKeep, 'principal component 2']
               , c = color
               , s = 50)
  ax.legend(targets)
  ax.grid()
```



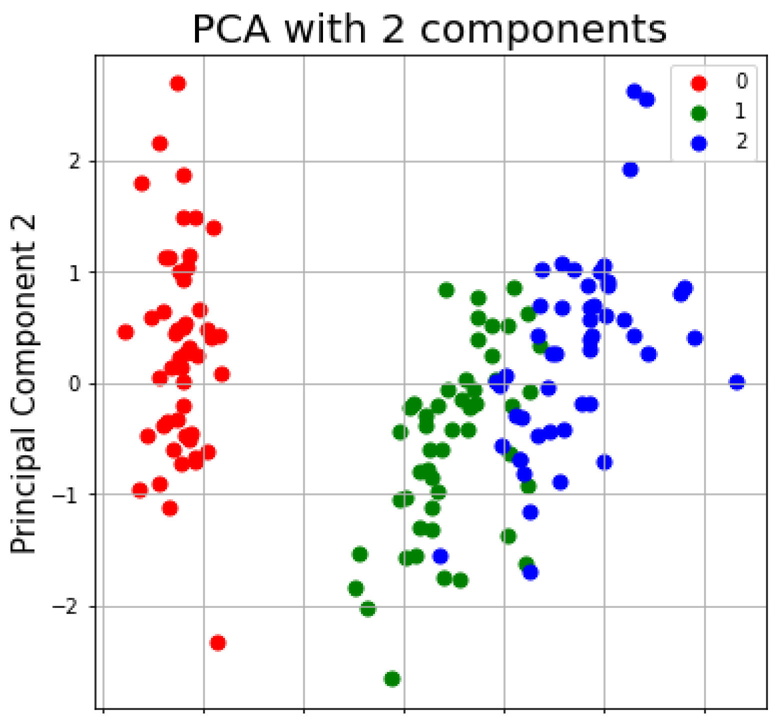
PCA characterized by sepal length



PCA characterized by sepal width

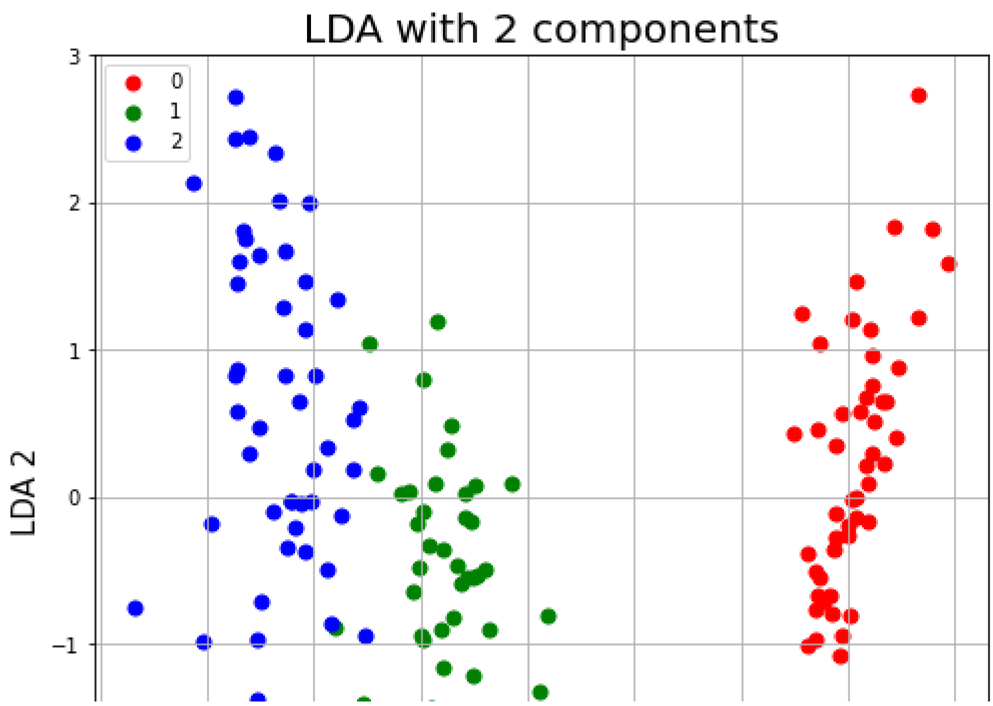


```
from sklearn.preprocessing import StandardScaler
# Standardizing the features
x = StandardScaler().fit_transform(x1)
#principal component analysis
from sklearn.decomposition import PCA
pca = PCA(n_components=2)
principalComponents = pca.fit_transform(x)
principalDf = pd.DataFrame(data = principalComponents
             , columns = ['principal component 1', 'principal component 2'])
finalDf = pd.concat([principalDf, df[['species']]], axis = 1)
fig = plt.figure(figsize = (6,6))
ax = fig.add_subplot(1,1,1)
ax.set_xlabel('Principal Component 1', fontsize = 15)
ax.set_ylabel('Principal Component 2', fontsize = 15)
ax.set_title('PCA with 2 components', fontsize = 20)
targets = [0, 1, 2]
colors = ['r', 'g', 'b']
for target, color in zip(targets,colors):
    indicesToKeep = finalDf['species'] == target
    ax.scatter(finalDf.loc[indicesToKeep, 'principal component 1']
               , finalDf.loc[indicesToKeep, 'principal component 2']
               , c = color
               , s = 50)
ax.legend(targets)
ax.grid()
```



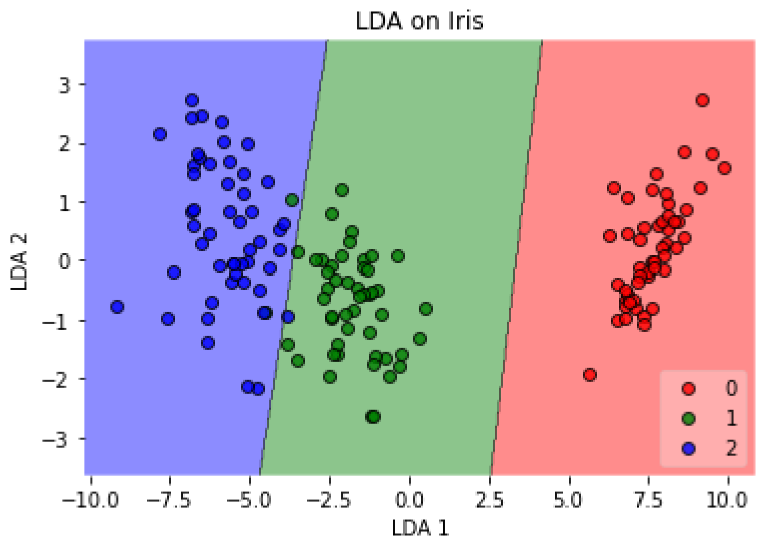
Q2 part2

```
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis as LDA
sklearn_lda = LDA(n_components=2)
x = StandardScaler().fit_transform(x1)
X_lda_sklearn = sklearn_lda.fit_transform(x, y1)

principalDf = pd.DataFrame(data = X_lda_sklearn
             , columns = ['LDA component 1', 'LDA component 2'])
finalDf = pd.concat([principalDf, df[['species']]], axis = 1)
fig = plt.figure(figsize = (8,8))
ax = fig.add_subplot(1,1,1)
ax.set_xlabel('LDA 1', fontsize = 15)
ax.set_ylabel('LDA 2', fontsize = 15)
ax.set_title('LDA with 2 components', fontsize = 20)
targets = [0, 1, 2]
colors = ['r', 'g', 'b']
for target, color in zip(targets,colors):
    indicesToKeep = finalDf['species'] == target
    ax.scatter(finalDf.loc[indicesToKeep, 'LDA component 1']
               , finalDf.loc[indicesToKeep, 'LDA component 2']
               , c = color
               , s = 50)
ax.legend(targets)
ax.grid()
```




```
from mlxtend.plotting import plot_decision_regions
import matplotlib.pyplot as plt
from sklearn import datasets
from sklearn.svm import SVC
svm = SVC(C=0.5, kernel='linear')
svm.fit(X_lda_sklearn, y1)
plot_decision_regions(X_lda_sklearn, y1, clf=svm, legend=4,colors="r,g,b",markers="oooooo"
plt.xlabel('LDA 1')
plt.ylabel('LDA 2')
plt.title('LDA on Iris')
plt.show()
```

```
/usr/local/lib/python3.6/dist-packages/mlxtend/plotting/decision_regions.py:244: Matp
  ax.axis(xmin=xx.min(), xmax=xx.max(), y_min=yy.min(), y_max=yy.max())
```




```
X_lda_sklearn
```

```
[ 7.12868772e+00, -7.86660426e-01],
[ 7.48982797e+00, -2.65384488e-01],
[ 6.81320057e+00, -6.70631068e-01],
[ 8.13230933e+00,  5.14462530e-01],
[ 7.70194674e+00,  1.46172097e+00],
[ 7.21261762e+00,  3.55836209e-01],
[ 7.60529355e+00, -1.16338380e-02],
[ 6.56055159e+00, -1.01516362e+00],
[ 7.34305989e+00, -9.47319209e-01],
[ 8.39738652e+00,  6.47363392e-01],
[ 7.21929685e+00, -1.09646389e-01],
[ 7.32679599e+00, -1.07298943e+00],
[ 7.57247066e+00, -8.05464137e-01],
[ 9.84984300e+00,  1.58593698e+00],
[ 9.15823890e+00,  2.73759647e+00],
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[ 7.78075375e+00,  5.84339407e-01],
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[ 6.25140358e+00,  4.39696367e-01],
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[ 7.99129024e+00,  8.63787128e-02],
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[ 9.12634625e+00,  1.22443267e+00],
[ 9.46768199e+00,  1.82522635e+00],
[ 7.06201386e+00, -6.63400423e-01],
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[ 8.33041759e+00,  2.28133530e-01],
[ 6.93412007e+00, -7.05519379e-01],
[ 7.68823131e+00, -9.22362309e-03],
[ 7.91793715e+00,  6.75121313e-01],
[ 5.66188065e+00, -1.93435524e+00],
[ 7.24101468e+00, -2.72615132e-01],
[ 6.41443556e+00,  1.24730131e+00],
[ 6.85944381e+00,  1.05165396e+00],
[ 6.76470393e+00, -5.05151855e-01],
[ 8.08189937e+00,  7.63392750e-01],
[ 7.18676904e+00, -3.60986823e-01],
[ 8.31444876e+00,  6.44953177e-01],
[ 7.67196741e+00, -1.34893840e-01],
[-1.45927545e+00,  2.85437643e-02],
[-1.79770574e+00,  4.84385502e-01],
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[-2.42996725e+00, -9.66132066e-01],
[-2.44848456e+00,  7.95961954e-01],
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[-1.75020123e+00, -8.21180130e-01],
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```

```
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       [-2.00598883e+00, -9.05418042e-01],
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```

```
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       [-6.65308685e+00,  1.80531976e+00],
       [-5.10555946e+00,  1.99218201e+00],
       [-5.50747997e+00, -3.58139892e-02],
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       [-6.84735943e+00,  2.42895067e+00],
       [-5.64500346e+00,  1.67771734e+00],
       [-5.17956460e+00, -3.63475041e-01],
```

```
df_new = pd.DataFrame(x1,
                      columns = iris.feature_names)
```

```
df_new['species']=y1
df_1=df_new.loc[df['species']<2]
df_1.head()
```

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	species
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

```
abc=df_1.to_numpy()
```

```
y1[0:50]
```

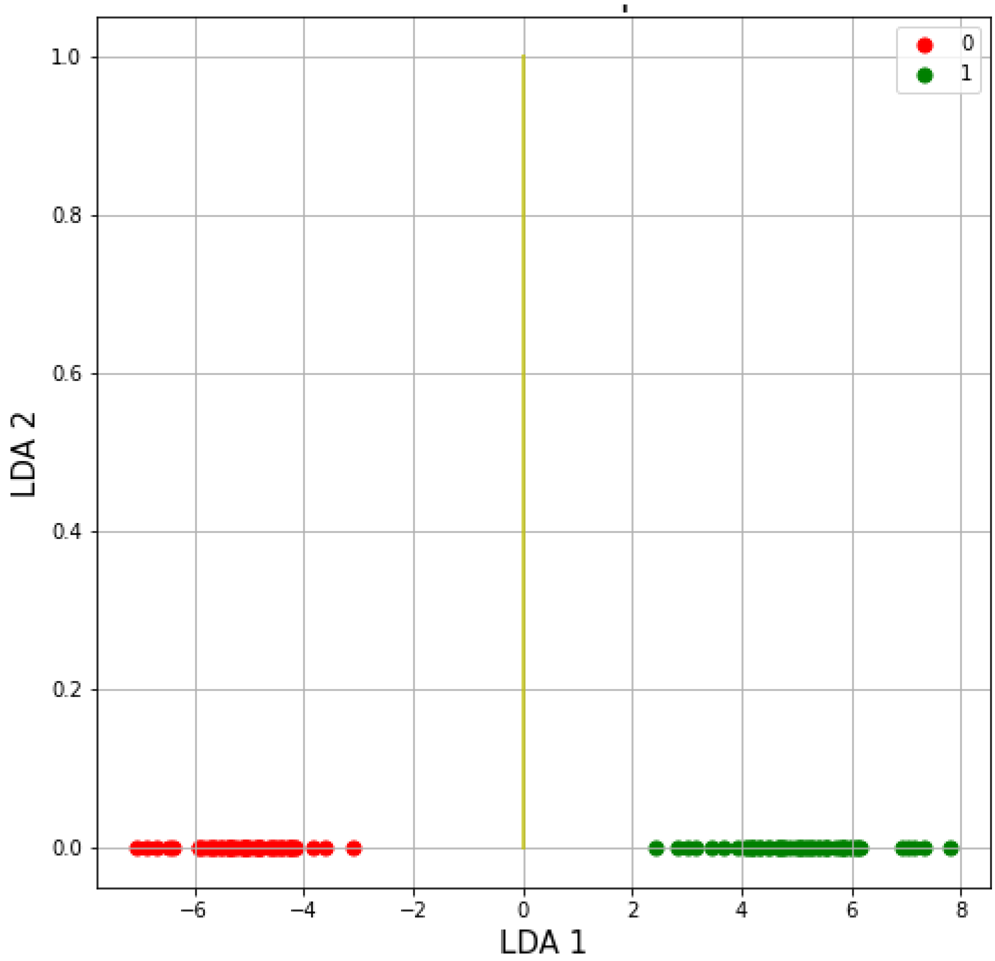
```
array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
```

```
x1[0:49,:].shape
```

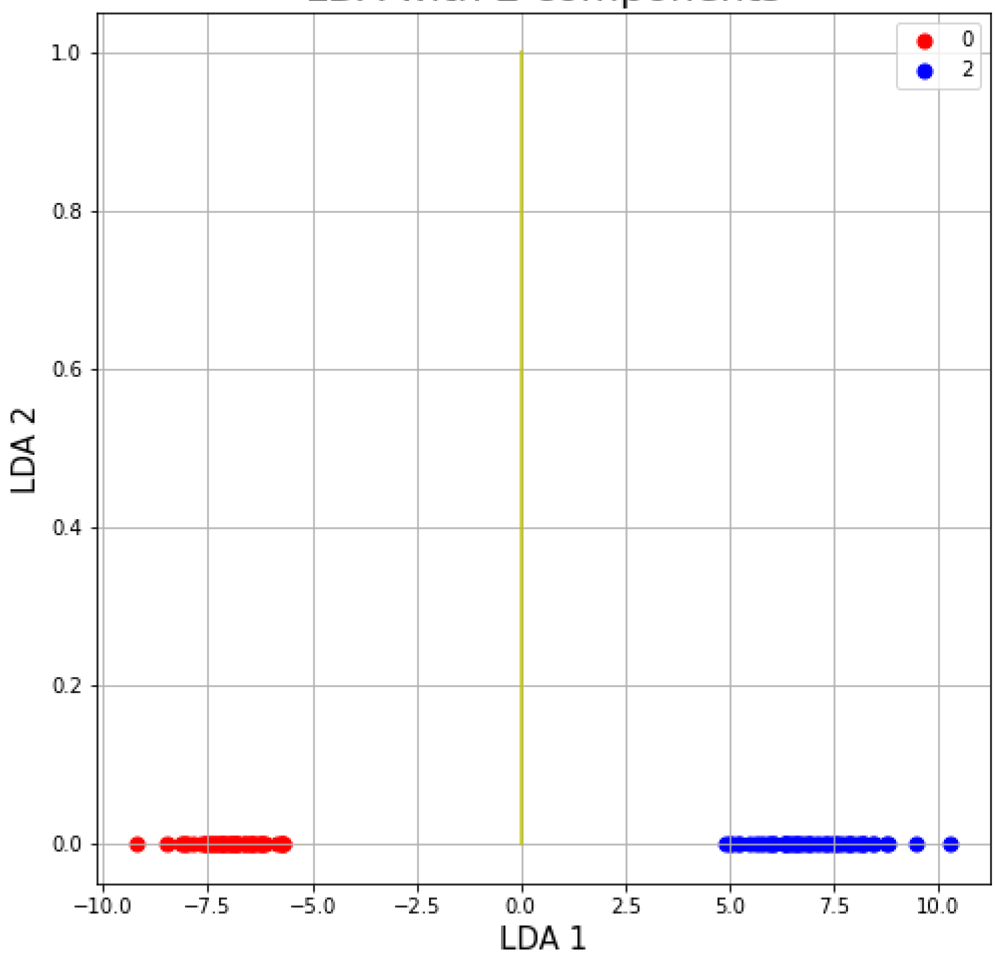
```
(49, 4)
```

```
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis as LDA
import matplotlib.pyplot as pp
import matplotlib.lines as lines
def plot_at_y(arr, val, **kwargs):
    pp.plot(arr, np.zeros_like(arr) + val, 'o', **kwargs)
    pp.show()
#1,2
sklearn_lda = LDA(n_components=1)
x = StandardScaler().fit_transform(x1[50:150,:])
X_lda_sklearn = sklearn_lda.fit_transform(x, y1[50:150])
print(y1[50:150])
principalDf = pd.DataFrame(data = X_lda_sklearn
             , columns = ['LDA component 1'])
df_st= pd.DataFrame( y1[50:150] ,columns=['species'] )
finalDf = pd.concat([principalDf, df_st], axis = 1)
fig = plt.figure(figsize = (8,8))
ax = fig.add_subplot(1,1,1)
ax.set_xlabel('LDA 1', fontsize = 15)
ax.set_ylabel('LDA 2', fontsize = 15)
ax.set_title('LDA with 2 components', fontsize = 20)
targets = [1, 2]
colors = ['g', 'b']
for target, color in zip(targets,colors):
    indicesToKeep = finalDf['species'] == target
    ax.scatter(finalDf.loc[indicesToKeep, 'LDA component 1'],[[0] for i in range(50)]
               , c = color
               , s = 50)
ax.legend(targets,)
line = lines.Line2D([0 , 0 ],
                    [0 , 1],
                    lw = 2, color ='y',
                    axes = ax, alpha = 0.7)

ax.add_line(line)

ax.grid()

#0,1
sklearn_lda = LDA(n_components=1)
x = StandardScaler().fit_transform(x1[0:100,:])
X_lda_sklearn = sklearn_lda.fit_transform(x, y1[0:100])
principalDf = pd.DataFrame(data = X_lda_sklearn
             , columns = ['LDA component 1'])
df_st= pd.DataFrame( y1[0:100] ,columns=['species'] )
finalDf = pd.concat([principalDf, df_st], axis = 1)
fig = plt.figure(figsize = (8,8))
ax = fig.add_subplot(1,1,1)
ax.set_xlabel('LDA 1', fontsize = 15)
```

```
ax.set_ylabel('LDA 2', fontsize = 15)
ax.set_title('LDA with 2 components', fontsize = 20)
targets = [0, 1]
colors = ['r', 'g']
for target, color in zip(targets,colors):
    indicesToKeep = finalDf['species'] == target
    ax.scatter(finalDf.loc[indicesToKeep, 'LDA component 1'],[[0] for i in range(50)]
               , c = color
               , s = 50)
ax.legend(targets)
line = lines.Line2D([0 , 0 ],
                    [0 , 1],
                    lw = 2, color ='y',
                    axes = ax, alpha = 0.7)

ax.add_line(line)

ax.grid()

#0,2
a= x1[0:50]
a=np.concatenate((a,x1[100:150]))
b= y1[0:50]
b = np.concatenate((b,y1[100:150]))
df_st= pd.DataFrame( b ,columns=['species'] )
sklearn_lda = LDA(n_components=1)
x = StandardScaler().fit_transform(a)
X_lda_sklearn = sklearn_lda.fit_transform(x, b)
principalDf = pd.DataFrame(data = X_lda_sklearn
             , columns = ['LDA component 1'])
finalDf = pd.concat([principalDf, df_st], axis = 1)
fig = plt.figure(figsize = (8,8))
ax = fig.add_subplot(1,1,1)
ax.set_xlabel('LDA 1', fontsize = 15)
ax.set_ylabel('LDA 2', fontsize = 15)
ax.set_title('LDA with 2 components', fontsize = 20)
targets = [0, 2]
colors = ['r', 'b']
for target, color in zip(targets,colors):
    indicesToKeep = finalDf['species'] == target
    ax.scatter(finalDf.loc[indicesToKeep, 'LDA component 1'],[[0] for i in range(50)]
               , c = color
               , s = 50)
ax.legend(targets)
line = lines.Line2D([0 , 0 ],
                    [0 , 1],
                    lw = 2, color ='y',
                    axes = ax, alpha = 0.7)

ax.add_line(line)

ax.grid()
```



LDA with 2 components

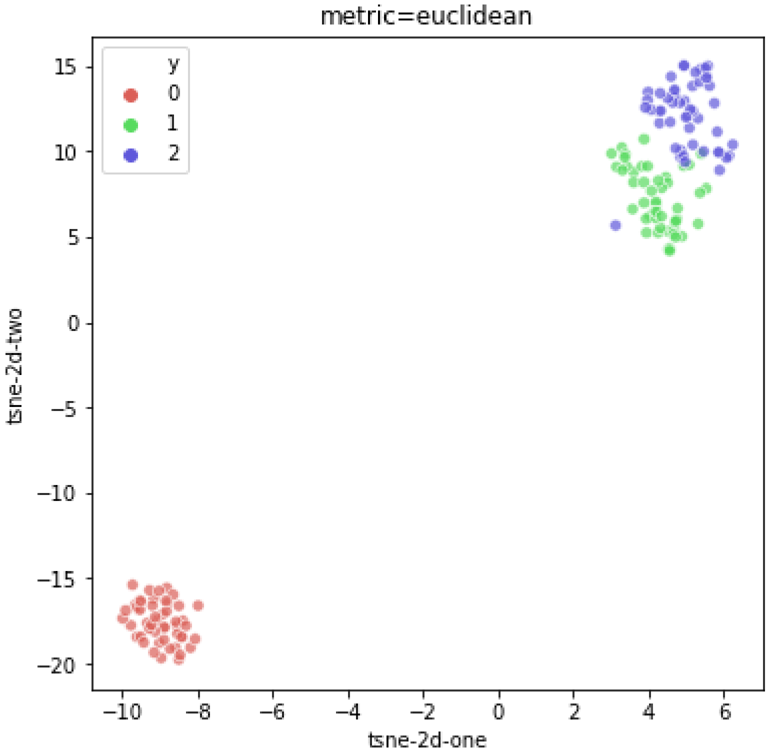


Q2 part3

```
from sklearn.manifold import TSNE
```

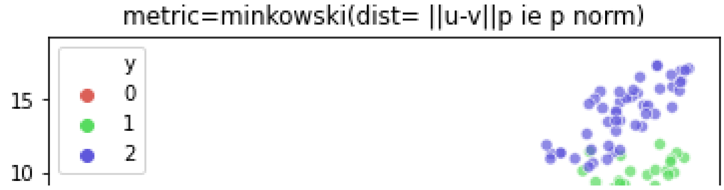
```
tsne=TSNE(n_components=2,perplexity=40,n_iter=1000).fit_transform(x1)
df_subset=pd.DataFrame(x1,columns=iris.feature_names)
df_subset['y']=y1
df_subset['tsne-2d-one'] = tsne[:,0]
df_subset['tsne-2d-two'] = tsne[:,1]
plt.figure(figsize=(6,6))
sns.scatterplot(
    x="tsne-2d-one", y="tsne-2d-two",
    hue="y",
    palette=sns.color_palette("hls", 3),
    data=df_subset,
    legend="full",
    alpha=0.7,
)
plt.title("metric=euclidean")
```

```
Text(0.5, 1.0, 'metric=euclidean')
```



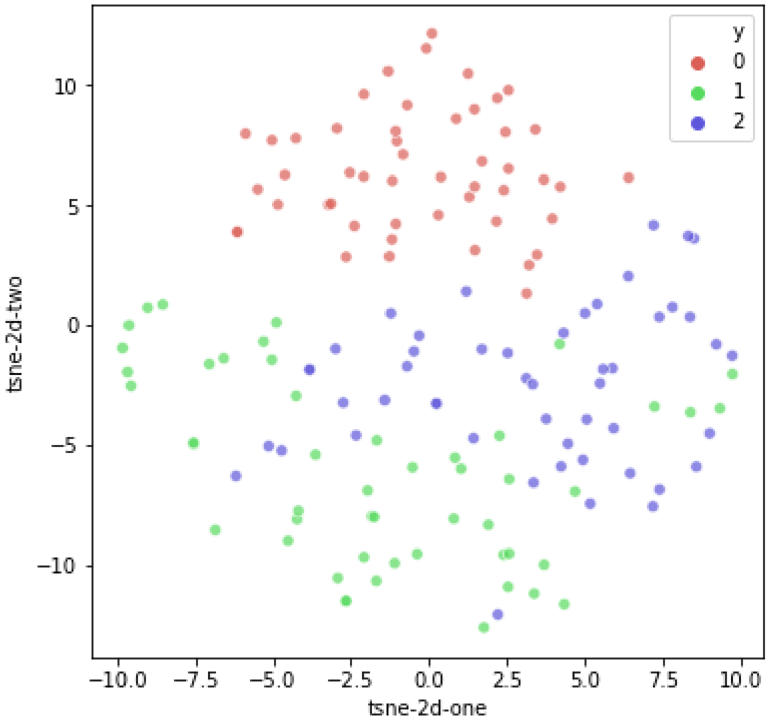

```
tsne=TSNE(n_components=2,perplexity=40,n_iter=1000,metric='minkowski').fit_transform(x1)
df_subset=pd.DataFrame(x1,columns=iris.feature_names)
df_subset['y']=y1
df_subset['tsne-2d-one'] = tsne[:,0]
df_subset['tsne-2d-two'] = tsne[:,1]
plt.figure(figsize=(6,6))
sns.scatterplot(
    x="tsne-2d-one", y="tsne-2d-two",
    hue="y",
    palette=sns.color_palette("hls", 3),
    data=df_subset,
    legend="full",
    alpha=0.7
)
plt.title("metric=minkowski(dist= ||u-v||p ie p norm)")
```

```
Text(0.5, 1.0, 'metric=minkowski(dist= ||u-v||p ie p norm)')
```




```
tsne=TSNE(n_components=2,perplexity=40,n_iter=1000,metric='hamming').fit_transform(x1)
df_subset=pd.DataFrame(x1,columns=iris.feature_names)
df_subset['y']=y1
df_subset['tsne-2d-one'] = tsne[:,0]
df_subset['tsne-2d-two'] = tsne[:,1]
plt.figure(figsize=(6,6))
sns.scatterplot(
    x="tsne-2d-one", y="tsne-2d-two",
    hue="y",
    palette=sns.color_palette("hls", 3),
    data=df_subset,
    legend="full",
    alpha=0.7
)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f40c01c0048>
```




```
tsne=TSNE(n_components=3,perplexity=40,n_iter=1000).fit_transform(x1)
df_subset['tsne-2d-one'] = tsne[:,0]
df_subset['tsne-2d-two'] = tsne[:,1]
df_subset['tsne-2d-three'] = tsne[:,2]
plt.figure(figsize=(8,8))
ax = plt.figure(figsize=(8,8)).gca(projection='3d')
ax.scatter(
    xs=df_subset["tsne-2d-one"],
    ys=df_subset["tsne-2d-two"],
    zs=df_subset["tsne-2d-three"],
```