

Subject : AML

Subject Code : 3CS1111

Roll No : 20MCED08

ANN MLP

STEP 1 : Importing Packages

```
In [7]: from sklearn.neural_network import MLPClassifier
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn import metrics
from sklearn.metrics import classification_report, confusion_matrix
from sklearn.datasets import load_iris
```

STEP 2 : Loading IRIS Dataset and Splitting the data

```
In [19]: FEATURE_NAMES = ['Sepal Length', 'Sepal Width', 'Petal Length', 'Petal Width']

iris = load_iris()
X = pd.DataFrame(iris.data, columns = FEATURE_NAMES)
y = iris.target

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=1)
```

STEP 3 : Creating the model and train the model

activation : {'identity', 'logistic', 'tanh', 'relu'}, default='relu' Activation function for the hidden layer.

- 'identity', no-op activation, useful to implement linear bottleneck, returns $f(x) = x$
- 'logistic', the logistic sigmoid function, returns $f(x) = 1 / (1 + \exp(-x))$.
- 'tanh', the hyperbolic tan function, returns $f(x) = \tanh(x)$.
- 'relu', the rectified linear unit function, returns $f(x) = \max(0, x)$

1. Activation Function = relu

```
In [20]: mlp = MLPClassifier(hidden_layer_sizes=(20,20),max_iter=1500)
mlp.fit(X_train,y_train)
predictions = mlp.predict(X_test)

print("Accuracy:",(metrics.accuracy_score(y_test, predictions))*100,'%')
```

Accuracy: 100.0 %

2. Activation Function = logistic

```
In [21]: mlp = MLPClassifier(hidden_layer_sizes=(20,20),max_iter=1500 ,activation='logistic')
mlp.fit(X_train,y_train)
predictions = mlp.predict(X_test)

print("Accuracy:",(metrics.accuracy_score(y_test, predictions))*100,'%')
```

Accuracy: 100.0 %

3 Activation Function = tanh

```
In [22]: mlp = MLPClassifier(hidden_layer_sizes=(20,20),max_iter=1500 ,activation='tanh')
mlp.fit(X_train,y_train)
predictions = mlp.predict(X_test)
```

```
print("Accuracy:",(metrics.accuracy_score(y_test, predictions))*100,'%')
```

Accuracy: 100.0 %

4. Activation Function = identity

```
In [25]: mlp = MLPClassifier(hidden_layer_sizes=(20,20),max_iter=1500 ,activation='identity')
mlp.fit(X_train,y_train)
predictions = mlp.predict(X_test)
```

```
print("Accuracy:",(metrics.accuracy_score(y_test, predictions))*100,'%')
```

Accuracy: 100.0 %

Keras Sequential

```

In [9]: import keras
from keras.models import Sequential
from keras.layers import Dense
from sklearn import datasets, metrics
import pandas as pd
from sklearn.preprocessing import OneHotEncoder

#w = pd.read_csv('E:/Iris.csv')
# print (w)
# X,y=datasets.load_iris(return_X_y=True)

FEATURE_NAMES = ['Sepal Length', 'Sepal Width', 'Petal Length', 'Petal Width']

iris = datasets.load_iris()

df1 = pd.DataFrame(iris.data, columns = FEATURE_NAMES)
df2 = pd.DataFrame(iris.target, columns = ['Target'])
df = pd.concat([df1,df2],axis='columns')

X = iris.data
y = iris.target.reshape(-1, 1)
names = iris['target_names']
feature_names = iris['feature_names']

print(df)

# One Hot encode the class labels
encoder = OneHotEncoder(sparse=False)
Y = encoder.fit_transform(y)

X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.2 , random
_state=1)

```

	Sepal Length	Sepal Width	Petal Length	Petal Width	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
..
145	6.7	3.0	5.2	2.3	2
146	6.3	2.5	5.0	1.9	2
147	6.5	3.0	5.2	2.0	2
148	6.2	3.4	5.4	2.3	2
149	5.9	3.0	5.1	1.8	2

[150 rows x 5 columns]

```
In [11]: model = Sequential()

model.add(Dense(units=4, input_shape=(4,), kernel_initializer = 'he_normal', activation = 'relu'))
# Hidden Layer
model.add(Dense(units=7, kernel_initializer='he_normal', activation='relu'))
# Output
model.add(Dense(units=3, kernel_initializer='he_normal', activation='sigmoid'))
# Adam optimizer with Learning rate of 0.001
# optimizer = Adam(Lr=0.001)
model.compile(optimizer = 'adam', loss='binary_crossentropy', metrics=['accuracy'])

print('Neural Network Model Summary: ')
print(model.summary())

model.fit(X_train, y_train, verbose=2, batch_size=5, epochs=500)
```

Neural Network Model Summary:

Model: "sequential_1"

Layer (type)	Output Shape	Param #
dense_3 (Dense)	(None, 4)	20
dense_4 (Dense)	(None, 7)	35
dense_5 (Dense)	(None, 3)	24

Total params: 79

Trainable params: 79

Non-trainable params: 0

None

Epoch 1/500

24/24 - 0s - loss: 2.1987 - accuracy: 0.3083

Epoch 2/500

24/24 - 0s - loss: 1.8271 - accuracy: 0.3083

Epoch 3/500

24/24 - 0s - loss: 1.5313 - accuracy: 0.3083

Epoch 4/500

24/24 - 0s - loss: 1.3096 - accuracy: 0.3083

Epoch 5/500

24/24 - 0s - loss: 1.1485 - accuracy: 0.3083

Epoch 6/500

24/24 - 0s - loss: 1.0234 - accuracy: 0.3083

Epoch 7/500

24/24 - 0s - loss: 0.9342 - accuracy: 0.3083

Epoch 8/500

24/24 - 0s - loss: 0.8682 - accuracy: 0.3083

Epoch 9/500

24/24 - 0s - loss: 0.8170 - accuracy: 0.3083

Epoch 10/500

24/24 - 0s - loss: 0.7797 - accuracy: 0.3083

Epoch 11/500

24/24 - 0s - loss: 0.7495 - accuracy: 0.3083

Epoch 12/500

24/24 - 0s - loss: 0.7270 - accuracy: 0.3083

Epoch 13/500

24/24 - 0s - loss: 0.7083 - accuracy: 0.3083

Epoch 14/500

24/24 - 0s - loss: 0.6925 - accuracy: 0.3167

Epoch 15/500

24/24 - 0s - loss: 0.6802 - accuracy: 0.3333

Epoch 16/500

24/24 - 0s - loss: 0.6699 - accuracy: 0.3750

Epoch 17/500

24/24 - 0s - loss: 0.6628 - accuracy: 0.4500

Epoch 18/500

24/24 - 0s - loss: 0.6585 - accuracy: 0.4833

Epoch 19/500

24/24 - 0s - loss: 0.6554 - accuracy: 0.4833

Epoch 20/500

24/24 - 0s - loss: 0.6526 - accuracy: 0.4833

Epoch 21/500

24/24 - 0s - loss: 0.6500 - accuracy: 0.4917
Epoch 22/500
24/24 - 0s - loss: 0.6474 - accuracy: 0.4667
Epoch 23/500
24/24 - 0s - loss: 0.6448 - accuracy: 0.4833
Epoch 24/500
24/24 - 0s - loss: 0.6421 - accuracy: 0.4917
Epoch 25/500
24/24 - 0s - loss: 0.6392 - accuracy: 0.4667
Epoch 26/500
24/24 - 0s - loss: 0.6367 - accuracy: 0.4500
Epoch 27/500
24/24 - 0s - loss: 0.6338 - accuracy: 0.4667
Epoch 28/500
24/24 - 0s - loss: 0.6311 - accuracy: 0.4583
Epoch 29/500
24/24 - 0s - loss: 0.6281 - accuracy: 0.4667
Epoch 30/500
24/24 - 0s - loss: 0.6255 - accuracy: 0.4500
Epoch 31/500
24/24 - 0s - loss: 0.6225 - accuracy: 0.4667
Epoch 32/500
24/24 - 0s - loss: 0.6196 - accuracy: 0.4667
Epoch 33/500
24/24 - 0s - loss: 0.6165 - accuracy: 0.4833
Epoch 34/500
24/24 - 0s - loss: 0.6134 - accuracy: 0.4833
Epoch 35/500
24/24 - 0s - loss: 0.6103 - accuracy: 0.4833
Epoch 36/500
24/24 - 0s - loss: 0.6070 - accuracy: 0.4917
Epoch 37/500
24/24 - 0s - loss: 0.6035 - accuracy: 0.4917
Epoch 38/500
24/24 - 0s - loss: 0.6003 - accuracy: 0.4583
Epoch 39/500
24/24 - 0s - loss: 0.5968 - accuracy: 0.4833
Epoch 40/500
24/24 - 0s - loss: 0.5931 - accuracy: 0.7167
Epoch 41/500
24/24 - 0s - loss: 0.5894 - accuracy: 0.7167
Epoch 42/500
24/24 - 0s - loss: 0.5856 - accuracy: 0.6917
Epoch 43/500
24/24 - 0s - loss: 0.5822 - accuracy: 0.6667
Epoch 44/500
24/24 - 0s - loss: 0.5778 - accuracy: 0.6667
Epoch 45/500
24/24 - 0s - loss: 0.5737 - accuracy: 0.6667
Epoch 46/500
24/24 - 0s - loss: 0.5695 - accuracy: 0.6667
Epoch 47/500
24/24 - 0s - loss: 0.5654 - accuracy: 0.6750
Epoch 48/500
24/24 - 0s - loss: 0.5609 - accuracy: 0.6750
Epoch 49/500
24/24 - 0s - loss: 0.5568 - accuracy: 0.6667

Epoch 50/500
24/24 - 0s - loss: 0.5520 - accuracy: 0.6667
Epoch 51/500
24/24 - 0s - loss: 0.5475 - accuracy: 0.6833
Epoch 52/500
24/24 - 0s - loss: 0.5428 - accuracy: 0.6750
Epoch 53/500
24/24 - 0s - loss: 0.5379 - accuracy: 0.6833
Epoch 54/500
24/24 - 0s - loss: 0.5332 - accuracy: 0.6833
Epoch 55/500
24/24 - 0s - loss: 0.5285 - accuracy: 0.6917
Epoch 56/500
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Epoch 57/500
24/24 - 0s - loss: 0.5185 - accuracy: 0.6833
Epoch 58/500
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Epoch 59/500
24/24 - 0s - loss: 0.5086 - accuracy: 0.6917
Epoch 60/500
24/24 - 0s - loss: 0.5037 - accuracy: 0.6917
Epoch 61/500
24/24 - 0s - loss: 0.4991 - accuracy: 0.6917
Epoch 62/500
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Epoch 63/500
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Epoch 64/500
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Epoch 65/500
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Epoch 66/500
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Epoch 67/500
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Epoch 68/500
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Epoch 69/500
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Epoch 70/500
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Epoch 71/500
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Epoch 72/500
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Epoch 73/500
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Epoch 75/500
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Epoch 76/500
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Epoch 77/500
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Epoch 78/500

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Epoch 79/500
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Epoch 80/500
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Epoch 81/500
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Epoch 82/500
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Epoch 83/500
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Epoch 84/500
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Epoch 85/500
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Epoch 86/500
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Epoch 87/500
24/24 - 0s - loss: 0.3983 - accuracy: 0.6917
Epoch 88/500
24/24 - 0s - loss: 0.3954 - accuracy: 0.7000
Epoch 89/500
24/24 - 0s - loss: 0.3930 - accuracy: 0.7000
Epoch 90/500
24/24 - 0s - loss: 0.3904 - accuracy: 0.7083
Epoch 91/500
24/24 - 0s - loss: 0.3881 - accuracy: 0.7000
Epoch 92/500
24/24 - 0s - loss: 0.3860 - accuracy: 0.7250
Epoch 93/500
24/24 - 0s - loss: 0.3833 - accuracy: 0.7167
Epoch 94/500
24/24 - 0s - loss: 0.3812 - accuracy: 0.7667
Epoch 95/500
24/24 - 0s - loss: 0.3787 - accuracy: 0.7500
Epoch 96/500
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Epoch 97/500
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Epoch 98/500
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Epoch 99/500
24/24 - 0s - loss: 0.3702 - accuracy: 0.7917
Epoch 100/500
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Epoch 101/500
24/24 - 0s - loss: 0.3664 - accuracy: 0.8000
Epoch 102/500
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Epoch 103/500
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Epoch 104/500
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Epoch 105/500
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Epoch 106/500
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Epoch 107/500
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Epoch 108/500
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Epoch 188/500
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Epoch 189/500
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Epoch 190/500
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Epoch 191/500
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Epoch 192/500

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Epoch 193/500
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Epoch 194/500
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Epoch 195/500
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Epoch 196/500
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Epoch 197/500
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Epoch 198/500
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Epoch 199/500
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Epoch 200/500
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Epoch 201/500
24/24 - 0s - loss: 0.2093 - accuracy: 0.9750
Epoch 202/500
24/24 - 0s - loss: 0.2075 - accuracy: 0.9750
Epoch 203/500
24/24 - 0s - loss: 0.2062 - accuracy: 0.9667
Epoch 204/500
24/24 - 0s - loss: 0.2053 - accuracy: 0.9667
Epoch 205/500
24/24 - 0s - loss: 0.2036 - accuracy: 0.9667
Epoch 206/500
24/24 - 0s - loss: 0.2023 - accuracy: 0.9667
Epoch 207/500
24/24 - 0s - loss: 0.2014 - accuracy: 0.9667
Epoch 208/500
24/24 - 0s - loss: 0.1992 - accuracy: 0.9667
Epoch 209/500
24/24 - 0s - loss: 0.1977 - accuracy: 0.9667
Epoch 210/500
24/24 - 0s - loss: 0.1969 - accuracy: 0.9667
Epoch 211/500
24/24 - 0s - loss: 0.1981 - accuracy: 0.9583
Epoch 212/500
24/24 - 0s - loss: 0.1960 - accuracy: 0.9667
Epoch 213/500
24/24 - 0s - loss: 0.1921 - accuracy: 0.9750
Epoch 214/500
24/24 - 0s - loss: 0.1914 - accuracy: 0.9750
Epoch 215/500
24/24 - 0s - loss: 0.1898 - accuracy: 0.9667
Epoch 216/500
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Epoch 217/500
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Epoch 218/500
24/24 - 0s - loss: 0.1860 - accuracy: 0.9750
Epoch 219/500
24/24 - 0s - loss: 0.1873 - accuracy: 0.9667
Epoch 220/500
24/24 - 0s - loss: 0.1830 - accuracy: 0.9667

Epoch 221/500
24/24 - 0s - loss: 0.1820 - accuracy: 0.9833
Epoch 222/500
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Epoch 223/500
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```

Out[11]: <tensorflow.python.keras.callbacks.History at 0x196c5c4f820>

```
In [12]: res = model.evaluate(X_test, y_test)

print('Final test set loss: ',res[0])
print('Final test set accuracy: ',res[1])
```

```
1/1 [=====] - 0s 152ms/step - loss: 0.0380 - accuracy: 1.0000
```

```
Final test set loss: 0.03797505050897598
```

```
Final test set accuracy: 1.0
```

```
In [90]: y_pred = (model.predict(X_test) > 0.5)
print("Accuracy:",metrics.accuracy_score(y_test, y_pred, normalize=True))
print(metrics.classification_report(y_test, y_pred))
# print(metrics.confusion_matrix(y_test, y_pred))
```

WARNING:tensorflow:6 out of the last 11 calls to <function Model.make_predict_function.<locals>.predict_function at 0x0000021A652579D0> triggered tf.function retracing. Tracing is expensive and the excessive number of tracings could be due to (1) creating @tf.function repeatedly in a loop, (2) passing tensors with different shapes, (3) passing Python objects instead of tensors. For (1), please define your @tf.function outside of the loop. For (2), @tf.function has experimental_relax_shapes=True option that relaxes argument shapes that can avoid unnecessary retracing. For (3), please refer to https://www.tensorflow.org/guide/function#controlling_retracing and https://www.tensorflow.org/api_docs/python/tf/function for more details.

```
Accuracy: 0.9666666666666667
```

	precision	recall	f1-score	support
0	1.00	1.00	1.00	11
1	1.00	0.92	0.96	13
2	0.86	1.00	0.92	6
micro avg	0.97	0.97	0.97	30
macro avg	0.95	0.97	0.96	30
weighted avg	0.97	0.97	0.97	30
samples avg	0.97	0.97	0.97	30

```
In [ ]:
```