OCR letter recognition using Deep Learning

```
import numpy as np
import pandas as pd
import tensorflow as tf
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import *
import matplotlib.pyplot as plt
```

```
/opt/conda/lib/python3.10/site-packages/tensorflow_io/python/ops/
__init__.py:98: UserWarning: unable to load
libtensorflow_io_plugins.so: unable to open file:
libtensorflow_io_plugins.so, from paths:
['/opt/conda/lib/python3.10/site-packages/tensorflow_io/python/ops/
libtensorflow_io_plugins.so']
caused by:
['/opt/conda/lib/python3.10/site-packages/tensorflow_io/python/ops/
libtensorflow_io_plugins.so: undefined symbol:
_ZN3tsl6StatusC1EN10tensorflow5error4CodeESt17basic_string_viewIcSt11c
har_traitsIcEENS_14SourceLocationE']
  warnings.warn(f"unable to load libtensorflow_io_plugins.so: {e}")
/opt/conda/lib/python3.10/site-packages/tensorflow_io/python/ops/__ini
t__.py:104: UserWarning: file system plugins are not loaded: unable to
open file: libtensorflow_io.so, from paths:
['/opt/conda/lib/python3.10/site-packages/tensorflow_io/python/ops/
libtensorflow_io.so']
caused by:
['/opt/conda/lib/python3.10/site-packages/tensorflow_io/python/ops/
libtensorflow_io.so: undefined symbol:
_ZTVN10tensorflow13GcsFileSystemE']
  warnings.warn(f"file system plugins are not loaded: {e}")
```

```
# Load the OCR letter recognition dataset
url =
'https://archive.ics.uci.edu/ml/machine-learning-databases/letter-
recognition/letter-recognition.data'
dataset = pd.read_csv(url, header=None)
```

OR

Load the OCR letter recognition dataset, Link

url = 'letter-recognition.data'

dataset = pd.read_csv(url, header=None)

```
# Split the dataset into features and labels
X = dataset.iloc[:, 1:].values  #selecting all rows and selecting all
```

```
columns from index 1
y = dataset.iloc[:, 0].values   #selecting all rows and selecting
column with index 0

print(y[0])
```

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```
# Encode the labels into numeric value
label_encoder = LabelEncoder()
y = label_encoder.fit_transform(y)

print(y[0])
```

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```
#splitting dataset into training and testing
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=1)

X_train = X_train / 15.0
X_test = X_test / 15.0

#we are using sequential model where layers are stacked one after
another,
#output of previous layer is given to as input to next layer

model = Sequential()
#1st layer is dense layer which consists on 128 neurons, since it is
1st layer we need to define input_shape of our training data
model.add(Dense(128, activation='relu', input_shape=(16,)))
model.add(Dropout(0.5))
model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(26, activation='softmax'))  #softmax is used to
predict multiclass category outcome

#now we will compile the model

#sparse_categorical_crossentropy (scce) produces a category index of
the most likely matching category.
model.compile(loss='sparse_categorical_crossentropy',
optimizer='adam', metrics =['accuracy'])

#The batch size is a number of samples processed before the model is
updated.
#verbose is the choice that how you want to see the output of your
Nural Network while it's training.
#If you set verbose = 0, It will show nothing
history = model.fit(X_train, y_train, validation_data=(X_test,
y_test), epochs=50, batch_size=12, verbose=1)
```

```
Epoch 1/50
1334/1334 [==============================] - 4s 3ms/step - loss:
2.6237 - accuracy: 0.2200 - val_loss: 1.7889 - val_accuracy: 0.5200
Epoch 2/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.8675 - accuracy: 0.4152 - val_loss: 1.4179 - val_accuracy: 0.5953
Epoch 3/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.6275 - accuracy: 0.4778 - val_loss: 1.2190 - val_accuracy: 0.6525
Epoch 4/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.4847 - accuracy: 0.5254 - val_loss: 1.1180 - val_accuracy: 0.6752
Epoch 5/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.4018 - accuracy: 0.5551 - val_loss: 1.0480 - val_accuracy: 0.6917
Epoch 6/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.3509 - accuracy: 0.5724 - val_loss: 0.9991 - val_accuracy: 0.7220
Epoch 7/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.2906 - accuracy: 0.5952 - val_loss: 0.9567 - val_accuracy: 0.7117
Epoch 8/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.2478 - accuracy: 0.6033 - val_loss: 0.9193 - val_accuracy: 0.7305
Epoch 9/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.2148 - accuracy: 0.6179 - val_loss: 0.8796 - val_accuracy: 0.7368
Epoch 10/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.1853 - accuracy: 0.6227 - val_loss: 0.8424 - val_accuracy: 0.7588
Epoch 11/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.1550 - accuracy: 0.6326 - val_loss: 0.8344 - val_accuracy: 0.7552
Epoch 12/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.1416 - accuracy: 0.6398 - val_loss: 0.7991 - val_accuracy: 0.7625
Epoch 13/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.1110 - accuracy: 0.6500 - val_loss: 0.7890 - val_accuracy: 0.7582
Epoch 14/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.0993 - accuracy: 0.6546 - val_loss: 0.7669 - val_accuracy: 0.7790
Epoch 15/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.0911 - accuracy: 0.6551 - val_loss: 0.7460 - val_accuracy: 0.7800
Epoch 16/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.0815 - accuracy: 0.6576 - val_loss: 0.7507 - val_accuracy: 0.7692
Epoch 17/50
1334/1334 [==============================] - 3s 2ms/step - loss:
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1.0675 - accuracy: 0.6633 - val_loss: 0.7371 - val_accuracy: 0.7835
Epoch 18/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.0426 - accuracy: 0.6670 - val_loss: 0.7095 - val_accuracy: 0.7928
Epoch 19/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.0241 - accuracy: 0.6747 - val_loss: 0.6862 - val_accuracy: 0.8018
Epoch 20/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.0250 - accuracy: 0.6739 - val_loss: 0.6884 - val_accuracy: 0.8030
Epoch 21/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.0161 - accuracy: 0.6771 - val_loss: 0.6768 - val_accuracy: 0.7940
Epoch 22/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9871 - accuracy: 0.6864 - val_loss: 0.6749 - val_accuracy: 0.7933
Epoch 23/50
1334/1334 [==============================] - 3s 2ms/step - loss:
1.0140 - accuracy: 0.6823 - val_loss: 0.6662 - val_accuracy: 0.8067
Epoch 24/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9924 - accuracy: 0.6890 - val_loss: 0.6563 - val_accuracy: 0.8025
Epoch 25/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9856 - accuracy: 0.6877 - val_loss: 0.6504 - val_accuracy: 0.8123
Epoch 26/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9879 - accuracy: 0.6846 - val_loss: 0.6529 - val_accuracy: 0.8115
Epoch 27/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9805 - accuracy: 0.6832 - val_loss: 0.6500 - val_accuracy: 0.8165
Epoch 28/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9765 - accuracy: 0.6931 - val_loss: 0.6297 - val_accuracy: 0.8165
Epoch 29/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9791 - accuracy: 0.6924 - val_loss: 0.6396 - val_accuracy: 0.8125
Epoch 30/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9591 - accuracy: 0.6978 - val_loss: 0.6327 - val_accuracy: 0.8117
Epoch 31/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9679 - accuracy: 0.6915 - val_loss: 0.6185 - val_accuracy: 0.8205
Epoch 32/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9586 - accuracy: 0.6957 - val_loss: 0.6110 - val_accuracy: 0.8253
Epoch 33/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9602 - accuracy: 0.6945 - val_loss: 0.6108 - val_accuracy: 0.8230
Epoch 34/50
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1334/1334 [==============================] - 3s 2ms/step - loss:
0.9362 - accuracy: 0.6998 - val_loss: 0.6139 - val_accuracy: 0.8255
Epoch 35/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9339 - accuracy: 0.6994 - val_loss: 0.5955 - val_accuracy: 0.8282
Epoch 36/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9429 - accuracy: 0.7021 - val_loss: 0.5999 - val_accuracy: 0.8265
Epoch 37/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9315 - accuracy: 0.7054 - val_loss: 0.5874 - val_accuracy: 0.8278
Epoch 38/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9401 - accuracy: 0.7034 - val_loss: 0.5890 - val_accuracy: 0.8278
Epoch 39/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9241 - accuracy: 0.7041 - val_loss: 0.5909 - val_accuracy: 0.8265
Epoch 40/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9168 - accuracy: 0.7109 - val_loss: 0.5894 - val_accuracy: 0.8305
Epoch 41/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9074 - accuracy: 0.7098 - val_loss: 0.5930 - val_accuracy: 0.8200
Epoch 42/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9054 - accuracy: 0.7084 - val_loss: 0.5810 - val_accuracy: 0.8255
Epoch 43/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9192 - accuracy: 0.7062 - val_loss: 0.5760 - val_accuracy: 0.8303
Epoch 44/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.8950 - accuracy: 0.7171 - val_loss: 0.5801 - val_accuracy: 0.8257
Epoch 45/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9087 - accuracy: 0.7116 - val_loss: 0.5602 - val_accuracy: 0.8313
Epoch 46/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9110 - accuracy: 0.7074 - val_loss: 0.5716 - val_accuracy: 0.8303
Epoch 47/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9053 - accuracy: 0.7141 - val_loss: 0.5759 - val_accuracy: 0.8313
Epoch 48/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.9121 - accuracy: 0.7105 - val_loss: 0.5714 - val_accuracy: 0.8332
Epoch 49/50
1334/1334 [==============================] - 3s 2ms/step - loss:
0.8995 - accuracy: 0.7120 - val_loss: 0.5664 - val_accuracy: 0.8360
Epoch 50/50
```

```
1334/1334 [==============================] - 3s 2ms/step - loss:
0.8945 - accuracy: 0.7156 - val_loss: 0.5663 - val_accuracy: 0.8322
```

```python
loss, accuracy = model.evaluate(X_test, y_test)
print("Test accuracy:", accuracy)
print("Test loss:", loss)
```

```
125/125 [==============================] - 0s 2ms/step - loss: 0.5663
- accuracy: 0.8322
Test accuracy: 0.8322499990463257
Test loss: 0.5662633776664734
```

```python
model.save('ocr_model.h5')
# Save the trained model
```

```python
from tensorflow.keras.models import load_model
model = load_model('ocr_model.h5')
# Load the trained model
```

```python
sample_records = X_test[:1000]
# Select a few records for classification
```

```python
# Perform classification
predictions = model.predict(sample_records)
```

```
32/32 [==============================] - 0s 1ms/step
```

```python
predicted_labels = np.argmax(predictions, axis=1)
predicted_letters = label_encoder.inverse_transform(predicted_labels)
actual_letters = label_encoder.inverse_transform(y_test)
```

```python
# Calculate accuracy
accuracy = np.sum(predicted_labels == y[:1000]) /
len(predicted_labels)
```

```python
# Print the predicted labels and corresponding actual labels
print("Predicted Labels\tActual Labels")
for i in range(len(predicted_letters)):
    print(f"{predicted_letters[i]}\t\t\t{actual_letters[i]}")
```

```
Predicted Labels	Actual Labels
D			D
D			D
V			V
B			B
H			H
N			N
E			E
Q			Q
X			R
N			N
Q			Q
```

O	O
N	N
D	D
I	I
M	M
U	U
S	S
O	O
A	A
X	X
A	A
K	K
S	S
O	O
V	V
Y	Y
J	J
D	D
V	V
D	D
V	V
K	K
T	F
N	N
I	I
G	G
T	T
H	H
K	K
J	J
O	O
M	M
T	T
B	B
Q	Q
Z	Z
C	C
D	D
X	X
K	C
G	G
Q	Q
F	F
N	N
Y	Y
Z	Z
K	K
S	C
K	T

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M                M
W                V
G                G
W                M
D                D
T                T
H                H
P                P
N                N
C                C
O                O
X                X
X                X
Q                Q
V                V
F                P
V                V
G                G
W                W
H                H
P                P
O                O
I                I
G                G
X                X
Y                X
Y                P
W                W
O                Q
D                D
D                N
G                Q
T                T
T                T
V                V
Y                Y
T                T
V                V
J                J
M                U
D                D
L                L
M                M
Y                Y
E                E
M                M
A                A
Y                Y
K                K
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Y                   Y
U                   U
U                   U
U                   U
K                   C
Q                   Q
I                   I
A                   A
E                   E
D                   D
T                   T
B                   P
Q                   Q
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X                   X
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E                   E
K                   K
Z                   Z
K                   X
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I                   I
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M                   M
J                   J
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R	R
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B	B
S	Z
N	N
W	W
Z	Z
W	W
V	V
B	S
V	Y
H	H
Q	O
Y	Y
V	V
S	S
W	W
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P	P
D	D
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Z               Z
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D                    D
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X                    F
Q                    Q
B                    B
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E                    E
R                    R
P                    P
R                    R
W                    W
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Y                    Y
Y                    Y
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C                    C
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H	H
E	C
Q	Q

F	F
B	B
O	O
I	I
K	K
O	O
D	R
Q	E
L	L
M	M
L	L
X	T
E	E
U	U
W	W
G	F
D	D
N	N
V	V
M	M
I	I
K	K
L	L
T	Y
Q	Q
F	F
U	U
J	J
V	V
M	M
P	P
W	W
L	L
A	A
L	L
B	B
Y	Y
I	I
D	D
R	R
T	T
Q	Q
B	B
O	U
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I	I
U	U
U	U

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X               K
X               J
I               I
W               W
Z               Z
Z               Z
P               P
A               A
Z               Z
P               P
V               V
B               G
B               B
G               G
O               O
V               V
D               D
Z               Z
Y               Y
P               P
Q               Q
A               A
E               E
W               W
D               D
J               J
I               I
J               J
X               X
B               S
Z               Z
G               G
X               T
U               U
K               K
G               G
I               I
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S               I
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Z                S
D                D
B                S
M                M
O                O
W                N
Y                Y
X                X
Q                Q
N                M
D                R
G                G
Q                G
A                A
R                K
U                U
U                O
B                P
C                C
V                V
B                D
B                B
A                A
K                E
D                R
T                T
I                I
S                Z
N                N
O                O
B                B
C                C
G                G
J                J
E                E
N                N
J                J
Q                H
D                P
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O                O
D                B
E                X
D                D
S                S
O                O
O                O
G                G
B                B
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R	H
C	C
A	A
W	W
P	P
I	I
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H	N
A	A
Y	H
U	K
N	N
M	M
F	F
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A	A
S	S
E	E
R	T
J	J
H	H
N	N
K	K
W	W
W	W
U	U
S	L
Z	Z
Z	Z
Z	Z
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J	J
V	V
W	W
L	L
M	M
U	U
W	W
O	G
A	A
T	T
J	J
C	C
G	G
D	D
T	Y

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Y                Y
X                X
N                N
Y                Y
S                S
K                K
U                U
M                W
R                R
B                B
T                T
R                R
H                H
R                R
M                M
O                O
W                W
X                X
R                R
X                X
N                N
R                H
C                C
E                C
J                J
V                V
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I                I
R                R
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O                H
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E                E
U                U
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A                A
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T                T
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Y                Y
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W                W
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Q                G
W                W
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L                L
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V                V
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K                C
F                F
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A                A
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T                T
H                H
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I                I
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B                R
J                J
K                R
K                K
A                A
Q                Q
Q                Q
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D                   H
V                   V
G                   G
Q                   Q
I                   I
T                   T
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