

In [1]:

```
# !unzip respiratory-sound-database.zip
```

In [2]:

```
# Load various imports
from datetime import datetime
from os import listdir
from os.path import isfile, join

import os
import librosa
import librosa.display

import numpy as np
import pandas as pd

from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout, Conv2D, MaxPooling2D, Global
AveragePooling2D
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.callbacks import ModelCheckpoint

from sklearn.metrics import confusion_matrix, classification_report, roc_curve,
auc
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder

import matplotlib.pyplot as plt
import seaborn as sns
```

In [3]:

```
import tensorflow as tf
gpus = tf.config.experimental.list_physical_devices('GPU')
if gpus:
    try:
        # Currently, memory growth needs to be the same across GPUs
        for gpu in gpus:
            tf.config.experimental.set_memory_growth(gpu, True)
        logical_gpus = tf.config.experimental.list_logical_devices('GPU')
        print(len(gpus), "Physical GPUs,", len(logical_gpus), "Logical GPUs")
    except RuntimeError as e:
        # Memory growth must be set before GPUs have been initialized
        print(e)
```

1 Physical GPUs, 1 Logical GPUs

In [4]:

```
mypath = "./Respiratory_Sound_Database/Respiratory_Sound_Database/audio_and_txt_
files/"
filenames = [f for f in listdir(mypath) if (isfile(join(mypath, f)) and f.endswi
th('.wav'))]
```

In [5]:

```
p_id_in_file = [] # patient IDs corresponding to each file
for name in filenames:
    p_id_in_file.append(int(name[:3]))

p_id_in_file = np.array(p_id_in_file)
```

In [6]:

```
max_pad_len = 862 # to make the length of all MFCC equal

os.makedirs("./Respiratory_Sound_Database/features/", exist_ok=True)

def extract_features(file_name):
    """
    This function takes in the path for an audio file as a string, loads it, and
    returns the MFCC
    of the audio"""
    feature = os.path.splitext(os.path.basename(file_name))[0] + ".npy"
    if (os.path.isfile(os.path.join("./Respiratory_Sound_Database/features/", fe
ature))):
        return np.load(os.path.join("./Respiratory_Sound_Database/features/", fe
ature))

    try:
        audio, sample_rate = librosa.load(file_name, res_type='kaiser_fast', dur
ation=20)
        mfccs = librosa.feature.mfcc(y=audio, sr=sample_rate, n_mfcc=40)
        pad_width = max_pad_len - mfccs.shape[1]
        mfccs = np.pad(mfccs, pad_width=((0, 0), (0, pad_width)), mode='constan
t')

    except Exception as e:
        print("Error encountered while parsing file: ", file_name)
        return None
    np.save(os.path.join("./Respiratory_Sound_Database/features/", feature), mfc
cs)
    return mfccs
```

In [7]:

```
filepaths = [join(mypath, f) for f in filenames] # full paths of files
```

In [8]:

```
p_diag = pd.read_csv("./Respiratory_Sound_Database/Respiratory_Sound_Database/pa
tient_diagnosis.csv", header=None) # patient diagnosis file
```

In [9]:

```
labels = np.array([p_diag[p_diag[0] == x][1].values[0] for x in p_id_in_file]) #
labels for audio files
```

In [10]:

```
features = []

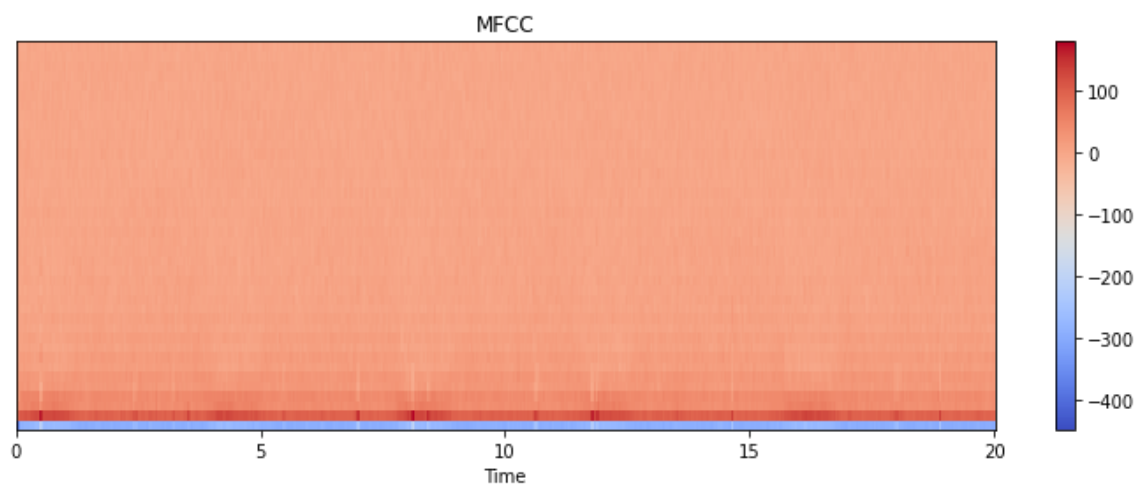
# Iterate through each sound file and extract the features
for file_name in filepaths:
    data = extract_features(file_name)
    features.append(data)

print('Finished feature extraction from ', len(features), ' files')
features = np.array(features)
```

Finished feature extraction from 920 files

In [11]:

```
# plot an MFCC
plt.figure(figsize=(10, 4))
librosa.display.specshow(features[7], x_axis='time')
plt.colorbar()
plt.title('MFCC')
plt.tight_layout()
plt.show()
```



In [12]:

```
features = np.array(features) # convert to numpy array
```

In [13]:

```
np.unique(labels)
```

Out[13]:

```
array(['Asthma', 'Bronchiectasis', 'Bronchiolitis', 'COPD', 'Health  
y',  
      'LRTI', 'Pneumonia', 'URTI'], dtype='<U14')
```

In [14]:

```
# delete diseases
'''
features1 = features
labels1 = labels'''

features1 = np.delete(features, np.where((labels == 'Asthma') | (labels == 'LRTI') | (labels == 'Bronchiectasis') | (labels == 'Bronchiolitis') | (labels == 'COPD') | (labels == "URTI"))[0], axis=0)

labels1 = np.delete(labels, np.where((labels == 'Asthma') | (labels == 'LRTI') | (labels == 'Bronchiectasis') | (labels == 'Bronchiolitis') | (labels == 'COPD') | (labels == "URTI"))[0], axis=0)
```

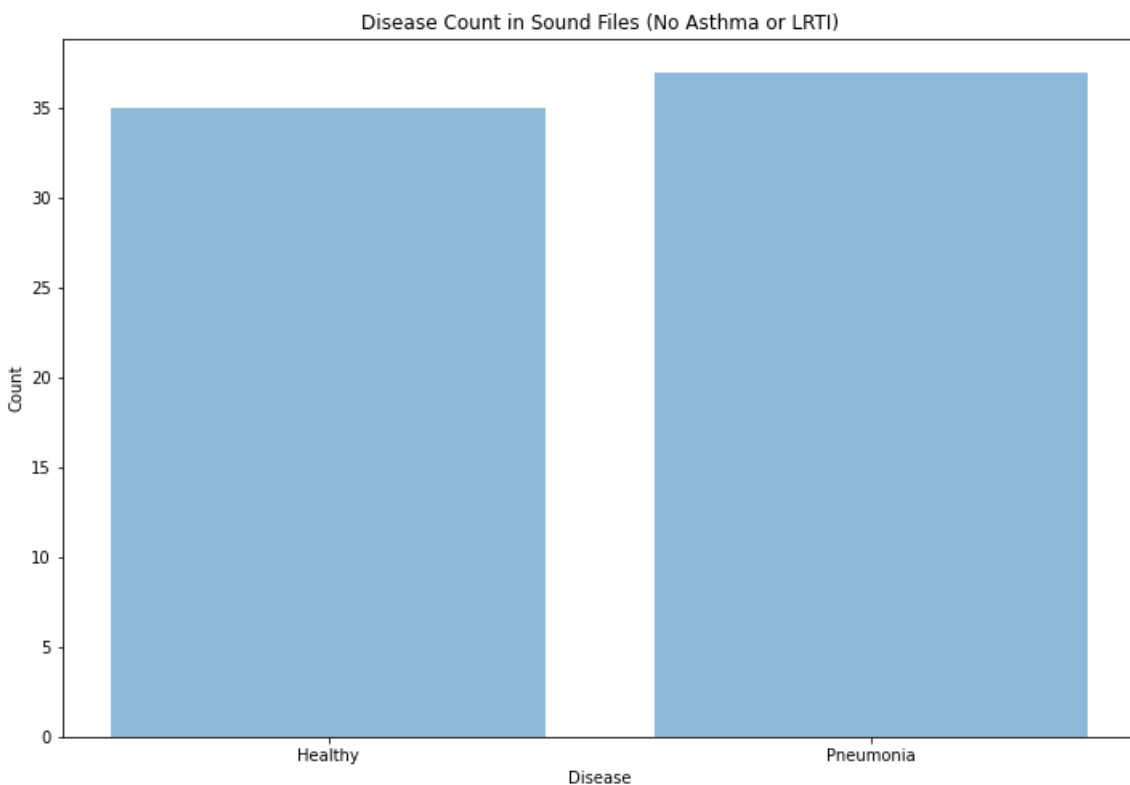
In [15]:

```
# print class counts
unique_elements, counts_elements = np.unique(labels1, return_counts=True)
print(np.asarray((unique_elements, counts_elements)))
```

```
[[ 'Healthy' 'Pneumonia']
 [ 35      37]]
```

In [16]:

```
# plot class counts
y_pos = np.arange(len(unique_elements))
plt.figure(figsize=(12,8))
plt.bar(unique_elements, counts_elements, align='center', alpha=0.5)
plt.xticks(y_pos, unique_elements)
plt.ylabel('Count')
plt.xlabel('Disease')
plt.title('Disease Count in Sound Files (No Asthma or LRTI)')
plt.show()
```



In [17]:

```
# One-hot encode labels
le = LabelEncoder()
i_labels = le.fit_transform(labels1)
oh_labels = to_categorical(i_labels)
```

In [18]:

```
features1.shape
```

Out[18]:

```
(72, 40, 862)
```

In [19]:

```
input_dim = features1.shape[1]*features1.shape[2]
features1 = np.reshape(features1, (features1.shape[0], input_dim))
print(features1.shape, labels1.shape)
```

```
(72, 34480) (72,)
```

In [20]:

```
# train test split
x_train, x_test, y_train, y_test = train_test_split(features1, oh_labels, strati
fy=oh_labels,
                                                    test_size=0.2, random_state
= 42)
```

MLP model architecture

In [21]:

```
num_labels = oh_labels.shape[1]
# Construct model
model = Sequential()
model.add(Dense(500, input_dim=input_dim, activation='relu'))
# model.add(Dropout(0.2))

model.add(Dense(500, activation='relu'))
# model.add(Dropout(0.2))

model.add(Dense(500, activation='relu'))
# model.add(Dropout(0.2))

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# model.add(Dropout(0.2))

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# model.add(Dropout(0.2))

model.add(Dense(500, activation='relu'))
# model.add(Dropout(0.2))

model.add(Dense(500, activation='relu'))
# model.add(Dropout(0.2))

model.add(Dense(num_labels, activation='softmax'))
```

In [22]:

```
# Compile the model
model.compile(loss='categorical_crossentropy', metrics=['accuracy'], optimizer=
'adam')
```

In [23]:

```
# Display model architecture summary
model.summary()

# Calculate pre-training accuracy
score = model.evaluate(x_test, y_test, verbose=1)
accuracy = 100*score[1]

print("Pre-training accuracy: %.4f%%" % accuracy)
```

Model: "sequential"

Layer (type)	Output Shape	Param #
dense (Dense)	(None, 500)	17240500
dense_1 (Dense)	(None, 500)	250500
dense_2 (Dense)	(None, 500)	250500
dense_3 (Dense)	(None, 500)	250500
dense_4 (Dense)	(None, 500)	250500
dense_5 (Dense)	(None, 500)	250500
dense_6 (Dense)	(None, 500)	250500
dense_7 (Dense)	(None, 500)	250500
dense_8 (Dense)	(None, 2)	1002

Total params: 18,995,002
 Trainable params: 18,995,002
 Non-trainable params: 0

15/15 [=====] - 0s 22ms/sample - loss: 1.34
 28 - accuracy: 0.2667
 Pre-training accuracy: 26.6667%

Training

Here we will train the model. If we have a trained model, we can load it instead from the next cell.

In [24]:

```
# train model
num_epochs = 250
num_batch_size = 10

os.makedirs('models', exist_ok=True)
callbacks = [
    ModelCheckpoint(
        filepath='models/model2_{epoch:02d}.h5',
        # Path where to save the model
        # The two parameters below mean that we will overwrite
        # the current checkpoint if and only if
        # the 'val_accuracy' score has improved.
        save_best_only=True,
        monitor='val_accuracy',
        verbose=1)
]
start = datetime.now()

history = model.fit(x_train, y_train, batch_size=num_batch_size, epochs=num_epochs,
                    validation_data=(x_test, y_test), callbacks=callbacks, verbose=1)

duration = datetime.now() - start
print("Training completed in time: ", duration)
```


Train on 57 samples, validate on 15 samples

Epoch 1/250

10/57 [====>.....] - ETA: 1s - loss: 1.0589 - accuracy: 0.5000

Epoch 00001: val_accuracy improved from -inf to 0.46667, saving model to models/model2_01.h5

57/57 [=====] - 1s 22ms/sample - loss: 205.1162 - accuracy: 0.4737 - val_loss: 13.7993 - val_accuracy: 0.4667

Epoch 2/250

10/57 [====>.....] - ETA: 0s - loss: 13.0839 - accuracy: 0.5000

Epoch 00002: val_accuracy improved from 0.46667 to 0.53333, saving model to models/model2_02.h5

57/57 [=====] - 1s 16ms/sample - loss: 30.2409 - accuracy: 0.5789 - val_loss: 18.7991 - val_accuracy: 0.5333

Epoch 3/250

10/57 [====>.....] - ETA: 0s - loss: 11.4793 - accuracy: 0.7000

Epoch 00003: val_accuracy did not improve from 0.53333

57/57 [=====] - 0s 2ms/sample - loss: 14.2188 - accuracy: 0.5439 - val_loss: 7.6492 - val_accuracy: 0.5333

Epoch 4/250

10/57 [====>.....] - ETA: 0s - loss: 5.8839 - accuracy: 0.6000

Epoch 00004: val_accuracy did not improve from 0.53333

57/57 [=====] - 0s 1ms/sample - loss: 11.6210 - accuracy: 0.4561 - val_loss: 7.3667 - val_accuracy: 0.4667

Epoch 5/250

10/57 [====>.....] - ETA: 0s - loss: 6.4073 - accuracy: 0.5000

Epoch 00005: val_accuracy did not improve from 0.53333

57/57 [=====] - 0s 1ms/sample - loss: 4.7923 - accuracy: 0.4561 - val_loss: 9.8107 - val_accuracy: 0.4667

Epoch 6/250

10/57 [====>.....] - ETA: 0s - loss: 5.7555 - accuracy: 0.7000

Epoch 00006: val_accuracy did not improve from 0.53333

57/57 [=====] - 0s 2ms/sample - loss: 5.2734 - accuracy: 0.5789 - val_loss: 4.4623 - val_accuracy: 0.4667

Epoch 7/250

10/57 [====>.....] - ETA: 0s - loss: 4.0057 - accuracy: 0.5000

Epoch 00007: val_accuracy did not improve from 0.53333

57/57 [=====] - 0s 1ms/sample - loss: 2.3066 - accuracy: 0.4912 - val_loss: 0.6454 - val_accuracy: 0.5333

Epoch 8/250

10/57 [====>.....] - ETA: 0s - loss: 0.6287 - accuracy: 0.6000

Epoch 00008: val_accuracy did not improve from 0.53333

57/57 [=====] - 0s 1ms/sample - loss: 1.0579 - accuracy: 0.5263 - val_loss: 0.6421 - val_accuracy: 0.5333

Epoch 9/250

10/57 [====>.....] - ETA: 0s - loss: 0.5371 - accuracy: 0.7000

Epoch 00009: val_accuracy did not improve from 0.53333

57/57 [=====] - 0s 1ms/sample - loss: 1.2724 - accuracy: 0.4737 - val_loss: 2.0290 - val_accuracy: 0.5333

Epoch 10/250

50/57 [=====>.....] - ETA: 0s - loss: 1.1869 - accuracy: 0.4600

Epoch 00010: val_accuracy did not improve from 0.53333

```
57/57 [=====] - 0s 2ms/sample - loss: 1.1081 - accuracy: 0.5263 - val_loss: 1.0017 - val_accuracy: 0.5333
Epoch 11/250
10/57 [====>.....] - ETA: 0s - loss: 0.5689 - accuracy: 0.7000
Epoch 00011: val_accuracy did not improve from 0.53333
57/57 [=====] - 0s 1ms/sample - loss: 0.7270 - accuracy: 0.5965 - val_loss: 0.7677 - val_accuracy: 0.5333
Epoch 12/250
10/57 [====>.....] - ETA: 0s - loss: 0.6428 - accuracy: 0.5000
Epoch 00012: val_accuracy did not improve from 0.53333
57/57 [=====] - 0s 1ms/sample - loss: 0.4770 - accuracy: 0.7368 - val_loss: 0.9772 - val_accuracy: 0.5333
Epoch 13/250
50/57 [=====>....] - ETA: 0s - loss: 0.4479 - accuracy: 0.7400
Epoch 00013: val_accuracy improved from 0.53333 to 0.80000, saving model to models/model2_13.h5
57/57 [=====] - 1s 15ms/sample - loss: 0.4685 - accuracy: 0.7193 - val_loss: 0.3756 - val_accuracy: 0.8000
Epoch 14/250
50/57 [=====>....] - ETA: 0s - loss: 0.2237 - accuracy: 0.9400
Epoch 00014: val_accuracy did not improve from 0.80000
57/57 [=====] - 0s 2ms/sample - loss: 0.2785 - accuracy: 0.8947 - val_loss: 0.4772 - val_accuracy: 0.6667
Epoch 15/250
10/57 [====>.....] - ETA: 0s - loss: 0.2091 - accuracy: 0.9000
Epoch 00015: val_accuracy did not improve from 0.80000
57/57 [=====] - 0s 1ms/sample - loss: 0.7052 - accuracy: 0.6667 - val_loss: 0.5313 - val_accuracy: 0.6667
Epoch 16/250
10/57 [====>.....] - ETA: 0s - loss: 0.1453 - accuracy: 1.0000
Epoch 00016: val_accuracy did not improve from 0.80000
57/57 [=====] - 0s 1ms/sample - loss: 0.2243 - accuracy: 0.9298 - val_loss: 0.3872 - val_accuracy: 0.8000
Epoch 17/250
10/57 [====>.....] - ETA: 0s - loss: 0.1226 - accuracy: 1.0000
Epoch 00017: val_accuracy did not improve from 0.80000
57/57 [=====] - 0s 1ms/sample - loss: 0.1742 - accuracy: 0.9298 - val_loss: 0.5761 - val_accuracy: 0.6667
Epoch 18/250
10/57 [====>.....] - ETA: 0s - loss: 0.3179 - accuracy: 0.9000
Epoch 00018: val_accuracy improved from 0.80000 to 0.93333, saving model to models/model2_18.h5
57/57 [=====] - 1s 16ms/sample - loss: 0.0969 - accuracy: 0.9825 - val_loss: 0.2703 - val_accuracy: 0.9333
Epoch 19/250
50/57 [=====>....] - ETA: 0s - loss: 0.0317 - accuracy: 1.0000
Epoch 00019: val_accuracy did not improve from 0.93333
57/57 [=====] - 0s 2ms/sample - loss: 0.0283 - accuracy: 1.0000 - val_loss: 1.2280 - val_accuracy: 0.6000
Epoch 20/250
10/57 [====>.....] - ETA: 0s - loss: 0.0073 - accuracy: 1.0000
```

Epoch 00020: val_accuracy did not improve from 0.93333
57/57 [=====] - 0s 1ms/sample - loss: 0.2053 - accuracy: 0.9123 - val_loss: 2.8933 - val_accuracy: 0.5333
Epoch 21/250
40/57 [=====>.....] - ETA: 0s - loss: 0.7534 - accuracy: 0.7000
Epoch 00021: val_accuracy did not improve from 0.93333
57/57 [=====] - 0s 2ms/sample - loss: 0.5865 - accuracy: 0.7544 - val_loss: 1.9685 - val_accuracy: 0.5333
Epoch 22/250
10/57 [=====>.....] - ETA: 0s - loss: 0.7331 - accuracy: 0.6000
Epoch 00022: val_accuracy did not improve from 0.93333
57/57 [=====] - 0s 1ms/sample - loss: 0.3792 - accuracy: 0.8421 - val_loss: 0.7278 - val_accuracy: 0.6000
Epoch 23/250
10/57 [=====>.....] - ETA: 0s - loss: 0.1756 - accuracy: 0.9000
Epoch 00023: val_accuracy did not improve from 0.93333
57/57 [=====] - 0s 1ms/sample - loss: 0.1223 - accuracy: 0.9474 - val_loss: 0.3718 - val_accuracy: 0.8000
Epoch 24/250
10/57 [=====>.....] - ETA: 0s - loss: 0.0130 - accuracy: 1.0000
Epoch 00024: val_accuracy did not improve from 0.93333
57/57 [=====] - 0s 1ms/sample - loss: 0.0295 - accuracy: 0.9825 - val_loss: 0.1053 - val_accuracy: 0.9333
Epoch 25/250
10/57 [=====>.....] - ETA: 0s - loss: 0.0438 - accuracy: 1.0000
Epoch 00025: val_accuracy did not improve from 0.93333
57/57 [=====] - 0s 1ms/sample - loss: 0.0081 - accuracy: 1.0000 - val_loss: 0.1020 - val_accuracy: 0.9333
Epoch 26/250
40/57 [=====>.....] - ETA: 0s - loss: 8.0302e-05 - accuracy: 1.0000
Epoch 00026: val_accuracy did not improve from 0.93333
57/57 [=====] - 0s 2ms/sample - loss: 2.3866e-04 - accuracy: 1.0000 - val_loss: 0.0939 - val_accuracy: 0.9333
Epoch 27/250
10/57 [=====>.....] - ETA: 0s - loss: 6.1273e-06 - accuracy: 1.0000
Epoch 00027: val_accuracy did not improve from 0.93333
57/57 [=====] - 0s 1ms/sample - loss: 1.6951e-05 - accuracy: 1.0000 - val_loss: 0.0825 - val_accuracy: 0.9333
Epoch 28/250
10/57 [=====>.....] - ETA: 0s - loss: 1.0610e-06 - accuracy: 1.0000
Epoch 00028: val_accuracy improved from 0.93333 to 1.00000, saving model to models/model2_28.h5
57/57 [=====] - 0s 8ms/sample - loss: 5.1614e-06 - accuracy: 1.0000 - val_loss: 0.0754 - val_accuracy: 1.0000
Epoch 29/250
10/57 [=====>.....] - ETA: 0s - loss: 4.9709e-06 - accuracy: 1.0000
Epoch 00029: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.0642e-06 - accuracy: 1.0000 - val_loss: 0.0729 - val_accuracy: 1.0000
Epoch 30/250
10/57 [=====>.....] - ETA: 0s - loss: 2.5391e-06 - accuracy: 1.0000

Epoch 00030: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 9.473
9e-07 - accuracy: 1.0000 - val_loss: 0.0708 - val_accuracy: 1.0000
Epoch 31/250
10/57 [====>.....] - ETA: 0s - loss: 1.1325e-06
- accuracy: 1.0000
Epoch 00031: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 5.123
9e-07 - accuracy: 1.0000 - val_loss: 0.0692 - val_accuracy: 1.0000
Epoch 32/250
10/57 [====>.....] - ETA: 0s - loss: 9.5367e-08
- accuracy: 1.0000
Epoch 00032: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 3.806
3e-07 - accuracy: 1.0000 - val_loss: 0.0677 - val_accuracy: 1.0000
Epoch 33/250
10/57 [====>.....] - ETA: 0s - loss: 6.4373e-07
- accuracy: 1.0000
Epoch 00033: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 3.241
6e-07 - accuracy: 1.0000 - val_loss: 0.0667 - val_accuracy: 1.0000
Epoch 34/250
10/57 [====>.....] - ETA: 0s - loss: 1.7881e-07
- accuracy: 1.0000
Epoch 00034: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.760
6e-07 - accuracy: 1.0000 - val_loss: 0.0660 - val_accuracy: 1.0000
Epoch 35/250
10/57 [====>.....] - ETA: 0s - loss: 1.7881e-07
- accuracy: 1.0000
Epoch 00035: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.551
5e-07 - accuracy: 1.0000 - val_loss: 0.0656 - val_accuracy: 1.0000
Epoch 36/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00036: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.405
1e-07 - accuracy: 1.0000 - val_loss: 0.0652 - val_accuracy: 1.0000
Epoch 37/250
10/57 [====>.....] - ETA: 0s - loss: 2.8610e-07
- accuracy: 1.0000
Epoch 00037: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.279
6e-07 - accuracy: 1.0000 - val_loss: 0.0649 - val_accuracy: 1.0000
Epoch 38/250
10/57 [====>.....] - ETA: 0s - loss: 3.5763e-08
- accuracy: 1.0000
Epoch 00038: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.175
0e-07 - accuracy: 1.0000 - val_loss: 0.0646 - val_accuracy: 1.0000
Epoch 39/250
10/57 [====>.....] - ETA: 0s - loss: 7.1526e-08
- accuracy: 1.0000
Epoch 00039: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.070
5e-07 - accuracy: 1.0000 - val_loss: 0.0644 - val_accuracy: 1.0000
Epoch 40/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00040: val_accuracy did not improve from 1.00000

```
57/57 [=====] - 0s 1ms/sample - loss: 2.007
7e-07 - accuracy: 1.0000 - val_loss: 0.0642 - val_accuracy: 1.0000
Epoch 41/250
10/57 [====>.....] - ETA: 0s - loss: 1.0729e-07
- accuracy: 1.0000
Epoch 00041: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.945
0e-07 - accuracy: 1.0000 - val_loss: 0.0640 - val_accuracy: 1.0000
Epoch 42/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00042: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.861
3e-07 - accuracy: 1.0000 - val_loss: 0.0639 - val_accuracy: 1.0000
Epoch 43/250
10/57 [====>.....] - ETA: 0s - loss: 2.0266e-07
- accuracy: 1.0000
Epoch 00043: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.798
6e-07 - accuracy: 1.0000 - val_loss: 0.0638 - val_accuracy: 1.0000
Epoch 44/250
10/57 [====>.....] - ETA: 0s - loss: 6.5565e-07
- accuracy: 1.0000
Epoch 00044: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.756
8e-07 - accuracy: 1.0000 - val_loss: 0.0636 - val_accuracy: 1.0000
Epoch 45/250
10/57 [====>.....] - ETA: 0s - loss: 8.3446e-07
- accuracy: 1.0000
Epoch 00045: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.673
1e-07 - accuracy: 1.0000 - val_loss: 0.0635 - val_accuracy: 1.0000
Epoch 46/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00046: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.610
4e-07 - accuracy: 1.0000 - val_loss: 0.0634 - val_accuracy: 1.0000
Epoch 47/250
10/57 [====>.....] - ETA: 0s - loss: 4.2915e-07
- accuracy: 1.0000
Epoch 00047: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.589
5e-07 - accuracy: 1.0000 - val_loss: 0.0633 - val_accuracy: 1.0000
Epoch 48/250
10/57 [====>.....] - ETA: 0s - loss: 2.2650e-07
- accuracy: 1.0000
Epoch 00048: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.526
7e-07 - accuracy: 1.0000 - val_loss: 0.0631 - val_accuracy: 1.0000
Epoch 49/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00049: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-07 - accuracy: 1.0000 - val_loss: 0.0629 - val_accuracy: 1.0000
Epoch 50/250
10/57 [====>.....] - ETA: 0s - loss: 5.9605e-08
- accuracy: 1.0000
Epoch 00050: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 2ms/sample - loss: 1.401
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2e-07 - accuracy: 1.0000 - val_loss: 0.0628 - val_accuracy: 1.0000
Epoch 51/250
10/57 [====>.....] - ETA: 0s - loss: 1.4305e-07
- accuracy: 1.0000
Epoch 00051: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.338
5e-07 - accuracy: 1.0000 - val_loss: 0.0626 - val_accuracy: 1.0000
Epoch 52/250
10/57 [====>.....] - ETA: 0s - loss: 1.6689e-07
- accuracy: 1.0000
Epoch 00052: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.317
6e-07 - accuracy: 1.0000 - val_loss: 0.0625 - val_accuracy: 1.0000
Epoch 53/250
10/57 [====>.....] - ETA: 0s - loss: 2.3842e-07
- accuracy: 1.0000
Epoch 00053: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.275
7e-07 - accuracy: 1.0000 - val_loss: 0.0624 - val_accuracy: 1.0000
Epoch 54/250
10/57 [====>.....] - ETA: 0s - loss: 2.7418e-07
- accuracy: 1.0000
Epoch 00054: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.233
9e-07 - accuracy: 1.0000 - val_loss: 0.0623 - val_accuracy: 1.0000
Epoch 55/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-07
- accuracy: 1.0000
Epoch 00055: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.171
2e-07 - accuracy: 1.0000 - val_loss: 0.0621 - val_accuracy: 1.0000
Epoch 56/250
10/57 [====>.....] - ETA: 0s - loss: 5.9605e-08
- accuracy: 1.0000
Epoch 00056: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.108
4e-07 - accuracy: 1.0000 - val_loss: 0.0619 - val_accuracy: 1.0000
Epoch 57/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00057: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.045
7e-07 - accuracy: 1.0000 - val_loss: 0.0617 - val_accuracy: 1.0000
Epoch 58/250
10/57 [====>.....] - ETA: 0s - loss: 4.0531e-07
- accuracy: 1.0000
Epoch 00058: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.045
7e-07 - accuracy: 1.0000 - val_loss: 0.0616 - val_accuracy: 1.0000
Epoch 59/250
10/57 [====>.....] - ETA: 0s - loss: 3.9339e-07
- accuracy: 1.0000
Epoch 00059: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.024
8e-07 - accuracy: 1.0000 - val_loss: 0.0614 - val_accuracy: 1.0000
Epoch 60/250
10/57 [====>.....] - ETA: 0s - loss: 2.7418e-07
- accuracy: 1.0000
Epoch 00060: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 9.829
5e-08 - accuracy: 1.0000 - val_loss: 0.0612 - val_accuracy: 1.0000
```

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Epoch 61/250
10/57 [====>.....] - ETA: 0s - loss: 7.1526e-08
- accuracy: 1.0000
Epoch 00061: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 9.202
1e-08 - accuracy: 1.0000 - val_loss: 0.0611 - val_accuracy: 1.0000
Epoch 62/250
10/57 [====>.....] - ETA: 0s - loss: 3.3379e-07
- accuracy: 1.0000
Epoch 00062: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.783
8e-08 - accuracy: 1.0000 - val_loss: 0.0608 - val_accuracy: 1.0000
Epoch 63/250
10/57 [====>.....] - ETA: 0s - loss: 9.5367e-08
- accuracy: 1.0000
Epoch 00063: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-08 - accuracy: 1.0000 - val_loss: 0.0606 - val_accuracy: 1.0000
Epoch 64/250
10/57 [====>.....] - ETA: 0s - loss: 2.3842e-07
- accuracy: 1.0000
Epoch 00064: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.156
4e-08 - accuracy: 1.0000 - val_loss: 0.0602 - val_accuracy: 1.0000
Epoch 65/250
10/57 [====>.....] - ETA: 0s - loss: 9.5367e-08
- accuracy: 1.0000
Epoch 00065: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 7.947
3e-08 - accuracy: 1.0000 - val_loss: 0.0598 - val_accuracy: 1.0000
Epoch 66/250
10/57 [====>.....] - ETA: 0s - loss: 2.0266e-07
- accuracy: 1.0000
Epoch 00066: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 7.529
0e-08 - accuracy: 1.0000 - val_loss: 0.0594 - val_accuracy: 1.0000
Epoch 67/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00067: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 7.319
9e-08 - accuracy: 1.0000 - val_loss: 0.0590 - val_accuracy: 1.0000
Epoch 68/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00068: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.901
6e-08 - accuracy: 1.0000 - val_loss: 0.0587 - val_accuracy: 1.0000
Epoch 69/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00069: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.901
6e-08 - accuracy: 1.0000 - val_loss: 0.0584 - val_accuracy: 1.0000
Epoch 70/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00070: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.483
3e-08 - accuracy: 1.0000 - val_loss: 0.0582 - val_accuracy: 1.0000
Epoch 71/250
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10/57 [====>.....] - ETA: 0s - loss: 7.1526e-08
- accuracy: 1.0000
Epoch 00071: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.483
3e-08 - accuracy: 1.0000 - val_loss: 0.0580 - val_accuracy: 1.0000
Epoch 72/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-07
- accuracy: 1.0000
Epoch 00072: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-08 - accuracy: 1.0000 - val_loss: 0.0579 - val_accuracy: 1.0000
Epoch 73/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00073: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.065
0e-08 - accuracy: 1.0000 - val_loss: 0.0577 - val_accuracy: 1.0000
Epoch 74/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00074: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 5.855
9e-08 - accuracy: 1.0000 - val_loss: 0.0576 - val_accuracy: 1.0000
Epoch 75/250
10/57 [====>.....] - ETA: 0s - loss: 1.4305e-07
- accuracy: 1.0000
Epoch 00075: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 5.855
9e-08 - accuracy: 1.0000 - val_loss: 0.0576 - val_accuracy: 1.0000
Epoch 76/250
10/57 [====>.....] - ETA: 0s - loss: 7.1526e-08
- accuracy: 1.0000
Epoch 00076: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 5.437
6e-08 - accuracy: 1.0000 - val_loss: 0.0575 - val_accuracy: 1.0000
Epoch 77/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00077: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 5.437
6e-08 - accuracy: 1.0000 - val_loss: 0.0574 - val_accuracy: 1.0000
Epoch 78/250
10/57 [====>.....] - ETA: 0s - loss: 1.4305e-07
- accuracy: 1.0000
Epoch 00078: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 5.228
5e-08 - accuracy: 1.0000 - val_loss: 0.0573 - val_accuracy: 1.0000
Epoch 79/250
10/57 [====>.....] - ETA: 0s - loss: 8.3446e-08
- accuracy: 1.0000
Epoch 00079: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 5.019
3e-08 - accuracy: 1.0000 - val_loss: 0.0572 - val_accuracy: 1.0000
Epoch 80/250
10/57 [====>.....] - ETA: 0s - loss: 1.7881e-07
- accuracy: 1.0000
Epoch 00080: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.810
2e-08 - accuracy: 1.0000 - val_loss: 0.0571 - val_accuracy: 1.0000
Epoch 81/250
10/57 [====>.....] - ETA: 0s - loss: 7.1526e-08
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- accuracy: 1.0000
Epoch 00081: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.601
1e-08 - accuracy: 1.0000 - val_loss: 0.0570 - val_accuracy: 1.0000
Epoch 82/250
10/57 [====>.....] - ETA: 0s - loss: 1.3113e-07
- accuracy: 1.0000
Epoch 00082: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.601
1e-08 - accuracy: 1.0000 - val_loss: 0.0570 - val_accuracy: 1.0000
Epoch 83/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00083: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.601
1e-08 - accuracy: 1.0000 - val_loss: 0.0569 - val_accuracy: 1.0000
Epoch 84/250
10/57 [====>.....] - ETA: 0s - loss: 1.5497e-07
- accuracy: 1.0000
Epoch 00084: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.391
9e-08 - accuracy: 1.0000 - val_loss: 0.0569 - val_accuracy: 1.0000
Epoch 85/250
10/57 [====>.....] - ETA: 0s - loss: 5.9605e-08
- accuracy: 1.0000
Epoch 00085: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.391
9e-08 - accuracy: 1.0000 - val_loss: 0.0567 - val_accuracy: 1.0000
Epoch 86/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00086: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 3.973
6e-08 - accuracy: 1.0000 - val_loss: 0.0567 - val_accuracy: 1.0000
Epoch 87/250
10/57 [====>.....] - ETA: 0s - loss: 5.9605e-08
- accuracy: 1.0000
Epoch 00087: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 3.973
6e-08 - accuracy: 1.0000 - val_loss: 0.0567 - val_accuracy: 1.0000
Epoch 88/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00088: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 3.764
5e-08 - accuracy: 1.0000 - val_loss: 0.0566 - val_accuracy: 1.0000
Epoch 89/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00089: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 3.555
4e-08 - accuracy: 1.0000 - val_loss: 0.0565 - val_accuracy: 1.0000
Epoch 90/250
10/57 [====>.....] - ETA: 0s - loss: 4.7684e-08
- accuracy: 1.0000
Epoch 00090: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 3.555
4e-08 - accuracy: 1.0000 - val_loss: 0.0564 - val_accuracy: 1.0000
Epoch 91/250
10/57 [====>.....] - ETA: 0s - loss: 8.3446e-08
- accuracy: 1.0000
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Epoch 00091: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 3.555
4e-08 - accuracy: 1.0000 - val_loss: 0.0564 - val_accuracy: 1.0000
Epoch 92/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00092: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 3.346
2e-08 - accuracy: 1.0000 - val_loss: 0.0563 - val_accuracy: 1.0000
Epoch 93/250
10/57 [====>.....] - ETA: 0s - loss: 9.5367e-08
- accuracy: 1.0000
Epoch 00093: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 3.346
2e-08 - accuracy: 1.0000 - val_loss: 0.0562 - val_accuracy: 1.0000
Epoch 94/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00094: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 2ms/sample - loss: 3.346
2e-08 - accuracy: 1.0000 - val_loss: 0.0563 - val_accuracy: 1.0000
Epoch 95/250
10/57 [====>.....] - ETA: 0s - loss: 7.1526e-08
- accuracy: 1.0000
Epoch 00095: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 2ms/sample - loss: 3.346
2e-08 - accuracy: 1.0000 - val_loss: 0.0561 - val_accuracy: 1.0000
Epoch 96/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00096: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 3.137
1e-08 - accuracy: 1.0000 - val_loss: 0.0559 - val_accuracy: 1.0000
Epoch 97/250
10/57 [====>.....] - ETA: 0s - loss: 1.0729e-07
- accuracy: 1.0000
Epoch 00097: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 3.137
1e-08 - accuracy: 1.0000 - val_loss: 0.0561 - val_accuracy: 1.0000
Epoch 98/250
10/57 [====>.....] - ETA: 0s - loss: 1.0729e-07
- accuracy: 1.0000
Epoch 00098: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.718
8e-08 - accuracy: 1.0000 - val_loss: 0.0561 - val_accuracy: 1.0000
Epoch 99/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00099: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.509
7e-08 - accuracy: 1.0000 - val_loss: 0.0562 - val_accuracy: 1.0000
Epoch 100/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00100: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.509
7e-08 - accuracy: 1.0000 - val_loss: 0.0559 - val_accuracy: 1.0000
Epoch 101/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00101: val_accuracy did not improve from 1.00000

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57/57 [=====] - 0s 1ms/sample - loss: 2.509
7e-08 - accuracy: 1.0000 - val_loss: 0.0559 - val_accuracy: 1.0000
Epoch 102/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00102: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.509
7e-08 - accuracy: 1.0000 - val_loss: 0.0558 - val_accuracy: 1.0000
Epoch 103/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00103: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.509
7e-08 - accuracy: 1.0000 - val_loss: 0.0558 - val_accuracy: 1.0000
Epoch 104/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00104: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.509
7e-08 - accuracy: 1.0000 - val_loss: 0.0559 - val_accuracy: 1.0000
Epoch 105/250
10/57 [====>.....] - ETA: 0s - loss: 4.7684e-08
- accuracy: 1.0000
Epoch 00105: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.300
5e-08 - accuracy: 1.0000 - val_loss: 0.0559 - val_accuracy: 1.0000
Epoch 106/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00106: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.300
5e-08 - accuracy: 1.0000 - val_loss: 0.0557 - val_accuracy: 1.0000
Epoch 107/250
10/57 [====>.....] - ETA: 0s - loss: 3.5763e-08
- accuracy: 1.0000
Epoch 00107: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.300
5e-08 - accuracy: 1.0000 - val_loss: 0.0557 - val_accuracy: 1.0000
Epoch 108/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00108: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.300
5e-08 - accuracy: 1.0000 - val_loss: 0.0560 - val_accuracy: 1.0000
Epoch 109/250
10/57 [====>.....] - ETA: 0s - loss: 4.7684e-08
- accuracy: 1.0000
Epoch 00109: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.300
5e-08 - accuracy: 1.0000 - val_loss: 0.0560 - val_accuracy: 1.0000
Epoch 110/250
50/57 [=====>.....] - ETA: 0s - loss: 1.9073e-08
- accuracy: 1.0000
Epoch 00110: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 2ms/sample - loss: 2.300
5e-08 - accuracy: 1.0000 - val_loss: 0.0558 - val_accuracy: 1.0000
Epoch 111/250
10/57 [====>.....] - ETA: 0s - loss: 3.5763e-08
- accuracy: 1.0000
Epoch 00111: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.300
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5e-08 - accuracy: 1.0000 - val_loss: 0.0556 - val_accuracy: 1.0000
Epoch 112/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00112: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.300
5e-08 - accuracy: 1.0000 - val_loss: 0.0558 - val_accuracy: 1.0000
Epoch 113/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00113: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.091
4e-08 - accuracy: 1.0000 - val_loss: 0.0559 - val_accuracy: 1.0000
Epoch 114/250
10/57 [====>.....] - ETA: 0s - loss: 3.5763e-08
- accuracy: 1.0000
Epoch 00114: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.882
3e-08 - accuracy: 1.0000 - val_loss: 0.0560 - val_accuracy: 1.0000
Epoch 115/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00115: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.882
3e-08 - accuracy: 1.0000 - val_loss: 0.0558 - val_accuracy: 1.0000
Epoch 116/250
10/57 [====>.....] - ETA: 0s - loss: 2.3842e-08
- accuracy: 1.0000
Epoch 00116: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.882
3e-08 - accuracy: 1.0000 - val_loss: 0.0557 - val_accuracy: 1.0000
Epoch 117/250
10/57 [====>.....] - ETA: 0s - loss: 3.5763e-08
- accuracy: 1.0000
Epoch 00117: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.882
3e-08 - accuracy: 1.0000 - val_loss: 0.0556 - val_accuracy: 1.0000
Epoch 118/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00118: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.673
1e-08 - accuracy: 1.0000 - val_loss: 0.0556 - val_accuracy: 1.0000
Epoch 119/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00119: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.673
1e-08 - accuracy: 1.0000 - val_loss: 0.0557 - val_accuracy: 1.0000
Epoch 120/250
10/57 [====>.....] - ETA: 0s - loss: 3.5763e-08
- accuracy: 1.0000
Epoch 00120: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.673
1e-08 - accuracy: 1.0000 - val_loss: 0.0557 - val_accuracy: 1.0000
Epoch 121/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00121: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0555 - val_accuracy: 1.0000
```

```
Epoch 122/250
10/57 [====>.....] - ETA: 0s - loss: 2.3842e-08
- accuracy: 1.0000
Epoch 00122: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0556 - val_accuracy: 1.0000
Epoch 123/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00123: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0554 - val_accuracy: 1.0000
Epoch 124/250
10/57 [====>.....] - ETA: 0s - loss: 2.3842e-08
- accuracy: 1.0000
Epoch 00124: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0554 - val_accuracy: 1.0000
Epoch 125/250
10/57 [====>.....] - ETA: 0s - loss: 2.3842e-08
- accuracy: 1.0000
Epoch 00125: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0553 - val_accuracy: 1.0000
Epoch 126/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00126: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0553 - val_accuracy: 1.0000
Epoch 127/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00127: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0552 - val_accuracy: 1.0000
Epoch 128/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00128: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0552 - val_accuracy: 1.0000
Epoch 129/250
10/57 [====>.....] - ETA: 0s - loss: 4.7684e-08
- accuracy: 1.0000
Epoch 00129: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0553 - val_accuracy: 1.0000
Epoch 130/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00130: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0552 - val_accuracy: 1.0000
Epoch 131/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00131: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0550 - val_accuracy: 1.0000
Epoch 132/250
```

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10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00132: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0550 - val_accuracy: 1.0000
Epoch 133/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00133: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0549 - val_accuracy: 1.0000
Epoch 134/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00134: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0549 - val_accuracy: 1.0000
Epoch 135/250
50/57 [=====>....] - ETA: 0s - loss: 9.5367e-09
- accuracy: 1.0000
Epoch 00135: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 2ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0552 - val_accuracy: 1.0000
Epoch 136/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00136: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0552 - val_accuracy: 1.0000
Epoch 137/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00137: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0552 - val_accuracy: 1.0000
Epoch 138/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00138: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0550 - val_accuracy: 1.0000
Epoch 139/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00139: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0551 - val_accuracy: 1.0000
Epoch 140/250
10/57 [====>.....] - ETA: 0s - loss: 2.3842e-08
- accuracy: 1.0000
Epoch 00140: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.464
0e-08 - accuracy: 1.0000 - val_loss: 0.0553 - val_accuracy: 1.0000
Epoch 141/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00141: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.254
8e-08 - accuracy: 1.0000 - val_loss: 0.0552 - val_accuracy: 1.0000
Epoch 142/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
```

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- accuracy: 1.0000
Epoch 00142: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.254
8e-08 - accuracy: 1.0000 - val_loss: 0.0551 - val_accuracy: 1.0000
Epoch 143/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00143: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.254
8e-08 - accuracy: 1.0000 - val_loss: 0.0549 - val_accuracy: 1.0000
Epoch 144/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00144: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.254
8e-08 - accuracy: 1.0000 - val_loss: 0.0548 - val_accuracy: 1.0000
Epoch 145/250
10/57 [====>.....] - ETA: 0s - loss: 2.3842e-08
- accuracy: 1.0000
Epoch 00145: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.045
7e-08 - accuracy: 1.0000 - val_loss: 0.0549 - val_accuracy: 1.0000
Epoch 146/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00146: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.045
7e-08 - accuracy: 1.0000 - val_loss: 0.0550 - val_accuracy: 1.0000
Epoch 147/250
10/57 [====>.....] - ETA: 0s - loss: 4.7684e-08
- accuracy: 1.0000
Epoch 00147: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.045
7e-08 - accuracy: 1.0000 - val_loss: 0.0550 - val_accuracy: 1.0000
Epoch 148/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00148: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.045
7e-08 - accuracy: 1.0000 - val_loss: 0.0550 - val_accuracy: 1.0000
Epoch 149/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00149: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 1.045
7e-08 - accuracy: 1.0000 - val_loss: 0.0551 - val_accuracy: 1.0000
Epoch 150/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00150: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0551 - val_accuracy: 1.0000
Epoch 151/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00151: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0552 - val_accuracy: 1.0000
Epoch 152/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
```

Epoch 00152: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0551 - val_accuracy: 1.0000
Epoch 153/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00153: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0552 - val_accuracy: 1.0000
Epoch 154/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00154: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0553 - val_accuracy: 1.0000
Epoch 155/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00155: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0553 - val_accuracy: 1.0000
Epoch 156/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00156: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0553 - val_accuracy: 1.0000
Epoch 157/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00157: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0554 - val_accuracy: 1.0000
Epoch 158/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00158: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0554 - val_accuracy: 1.0000
Epoch 159/250
50/57 [=====>....] - ETA: 0s - loss: 7.1526e-09
- accuracy: 1.0000
Epoch 00159: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 2ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0554 - val_accuracy: 1.0000
Epoch 160/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00160: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0553 - val_accuracy: 1.0000
Epoch 161/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00161: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0554 - val_accuracy: 1.0000
Epoch 162/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00162: val_accuracy did not improve from 1.00000


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57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0555 - val_accuracy: 1.0000
Epoch 163/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00163: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0556 - val_accuracy: 1.0000
Epoch 164/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00164: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0556 - val_accuracy: 1.0000
Epoch 165/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00165: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 8.365
6e-09 - accuracy: 1.0000 - val_loss: 0.0557 - val_accuracy: 1.0000
Epoch 166/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00166: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0557 - val_accuracy: 1.0000
Epoch 167/250
10/57 [====>.....] - ETA: 0s - loss: 2.3842e-08
- accuracy: 1.0000
Epoch 00167: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0557 - val_accuracy: 1.0000
Epoch 168/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00168: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0557 - val_accuracy: 1.0000
Epoch 169/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00169: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0558 - val_accuracy: 1.0000
Epoch 170/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00170: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0559 - val_accuracy: 1.0000
Epoch 171/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00171: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0559 - val_accuracy: 1.0000
Epoch 172/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00172: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
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2e-09 - accuracy: 1.0000 - val_loss: 0.0560 - val_accuracy: 1.0000
Epoch 173/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00173: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0561 - val_accuracy: 1.0000
Epoch 174/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00174: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0562 - val_accuracy: 1.0000
Epoch 175/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00175: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0563 - val_accuracy: 1.0000
Epoch 176/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00176: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0564 - val_accuracy: 1.0000
Epoch 177/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00177: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0564 - val_accuracy: 1.0000
Epoch 178/250
10/57 [====>.....] - ETA: 0s - loss: 2.3842e-08
- accuracy: 1.0000
Epoch 00178: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0564 - val_accuracy: 1.0000
Epoch 179/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00179: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0563 - val_accuracy: 1.0000
Epoch 180/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00180: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0565 - val_accuracy: 1.0000
Epoch 181/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00181: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0566 - val_accuracy: 1.0000
Epoch 182/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00182: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0566 - val_accuracy: 1.0000
```

Epoch 183/250

50/57 [=====>....] - ETA: 0s - loss: 7.1526e-09

- accuracy: 1.0000

Epoch 00183: val_accuracy did not improve from 1.00000

57/57 [=====] - 0s 2ms/sample - loss: 6.274

2e-09 - accuracy: 1.0000 - val_loss: 0.0567 - val_accuracy: 1.0000

Epoch 184/250

10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08

- accuracy: 1.0000

Epoch 00184: val_accuracy did not improve from 1.00000

57/57 [=====] - 0s 1ms/sample - loss: 6.274

2e-09 - accuracy: 1.0000 - val_loss: 0.0566 - val_accuracy: 1.0000

Epoch 185/250

10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00

- accuracy: 1.0000

Epoch 00185: val_accuracy did not improve from 1.00000

57/57 [=====] - 0s 1ms/sample - loss: 6.274

2e-09 - accuracy: 1.0000 - val_loss: 0.0569 - val_accuracy: 1.0000

Epoch 186/250

10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08

- accuracy: 1.0000

Epoch 00186: val_accuracy did not improve from 1.00000

57/57 [=====] - 0s 1ms/sample - loss: 6.274

2e-09 - accuracy: 1.0000 - val_loss: 0.0570 - val_accuracy: 1.0000

Epoch 187/250

10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08

- accuracy: 1.0000

Epoch 00187: val_accuracy did not improve from 1.00000

57/57 [=====] - 0s 1ms/sample - loss: 6.274

2e-09 - accuracy: 1.0000 - val_loss: 0.0571 - val_accuracy: 1.0000

Epoch 188/250

10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08

- accuracy: 1.0000

Epoch 00188: val_accuracy did not improve from 1.00000

57/57 [=====] - 0s 1ms/sample - loss: 6.274

2e-09 - accuracy: 1.0000 - val_loss: 0.0570 - val_accuracy: 1.0000

Epoch 189/250

10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08

- accuracy: 1.0000

Epoch 00189: val_accuracy did not improve from 1.00000

57/57 [=====] - 0s 1ms/sample - loss: 6.274

2e-09 - accuracy: 1.0000 - val_loss: 0.0571 - val_accuracy: 1.0000

Epoch 190/250

10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00

- accuracy: 1.0000

Epoch 00190: val_accuracy did not improve from 1.00000

57/57 [=====] - 0s 1ms/sample - loss: 6.274

2e-09 - accuracy: 1.0000 - val_loss: 0.0570 - val_accuracy: 1.0000

Epoch 191/250

10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08

- accuracy: 1.0000

Epoch 00191: val_accuracy did not improve from 1.00000

57/57 [=====] - 0s 1ms/sample - loss: 6.274

2e-09 - accuracy: 1.0000 - val_loss: 0.0571 - val_accuracy: 1.0000

Epoch 192/250

10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00

- accuracy: 1.0000

Epoch 00192: val_accuracy did not improve from 1.00000

57/57 [=====] - 0s 1ms/sample - loss: 6.274

2e-09 - accuracy: 1.0000 - val_loss: 0.0572 - val_accuracy: 1.0000

Epoch 193/250

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10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00193: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0572 - val_accuracy: 1.0000
Epoch 194/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00194: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0572 - val_accuracy: 1.0000
Epoch 195/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00195: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0572 - val_accuracy: 1.0000
Epoch 196/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00196: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0572 - val_accuracy: 1.0000
Epoch 197/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00197: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0572 - val_accuracy: 1.0000
Epoch 198/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00198: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0573 - val_accuracy: 1.0000
Epoch 199/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00199: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0574 - val_accuracy: 1.0000
Epoch 200/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00200: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0573 - val_accuracy: 1.0000
Epoch 201/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00201: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0573 - val_accuracy: 1.0000
Epoch 202/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00202: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0573 - val_accuracy: 1.0000
Epoch 203/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
```

```
- accuracy: 1.0000
Epoch 00203: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0573 - val_accuracy: 1.0000
Epoch 204/250
50/57 [=====>....] - ETA: 0s - loss: 7.1526e-09
- accuracy: 1.0000
Epoch 00204: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 2ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0575 - val_accuracy: 1.0000
Epoch 205/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00205: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0575 - val_accuracy: 1.0000
Epoch 206/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00206: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0576 - val_accuracy: 1.0000
Epoch 207/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00207: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0576 - val_accuracy: 1.0000
Epoch 208/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00208: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0577 - val_accuracy: 1.0000
Epoch 209/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00209: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0578 - val_accuracy: 1.0000
Epoch 210/250
10/57 [====>.....] - ETA: 0s - loss: 2.3842e-08
- accuracy: 1.0000
Epoch 00210: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0578 - val_accuracy: 1.0000
Epoch 211/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00211: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0578 - val_accuracy: 1.0000
Epoch 212/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00212: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0578 - val_accuracy: 1.0000
Epoch 213/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
```

Epoch 00213: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0577 - val_accuracy: 1.0000
Epoch 214/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00214: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0578 - val_accuracy: 1.0000
Epoch 215/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00215: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0577 - val_accuracy: 1.0000
Epoch 216/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00216: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 6.274
2e-09 - accuracy: 1.0000 - val_loss: 0.0579 - val_accuracy: 1.0000
Epoch 217/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00217: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0579 - val_accuracy: 1.0000
Epoch 218/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00218: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0578 - val_accuracy: 1.0000
Epoch 219/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00219: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0577 - val_accuracy: 1.0000
Epoch 220/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00220: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0575 - val_accuracy: 1.0000
Epoch 221/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00221: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0573 - val_accuracy: 1.0000
Epoch 222/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00222: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0570 - val_accuracy: 1.0000
Epoch 223/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00223: val_accuracy did not improve from 1.00000

```
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0568 - val_accuracy: 1.0000
Epoch 224/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00224: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0567 - val_accuracy: 1.0000
Epoch 225/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00225: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0565 - val_accuracy: 1.0000
Epoch 226/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00226: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0563 - val_accuracy: 1.0000
Epoch 227/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00227: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0562 - val_accuracy: 1.0000
Epoch 228/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00228: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0560 - val_accuracy: 1.0000
Epoch 229/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00229: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0557 - val_accuracy: 1.0000
Epoch 230/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00230: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0555 - val_accuracy: 1.0000
Epoch 231/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00231: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0552 - val_accuracy: 1.0000
Epoch 232/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00232: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0552 - val_accuracy: 1.0000
Epoch 233/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00233: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
```

```
8e-09 - accuracy: 1.0000 - val_loss: 0.0551 - val_accuracy: 1.0000
Epoch 234/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00234: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0550 - val_accuracy: 1.0000
Epoch 235/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00235: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0550 - val_accuracy: 1.0000
Epoch 236/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00236: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0550 - val_accuracy: 1.0000
Epoch 237/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00237: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0549 - val_accuracy: 1.0000
Epoch 238/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00238: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0548 - val_accuracy: 1.0000
Epoch 239/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00239: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0547 - val_accuracy: 1.0000
Epoch 240/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00240: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 2ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0545 - val_accuracy: 1.0000
Epoch 241/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00241: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0544 - val_accuracy: 1.0000
Epoch 242/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00242: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 4.182
8e-09 - accuracy: 1.0000 - val_loss: 0.0544 - val_accuracy: 1.0000
Epoch 243/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00243: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.091
4e-09 - accuracy: 1.0000 - val_loss: 0.0543 - val_accuracy: 1.0000
```



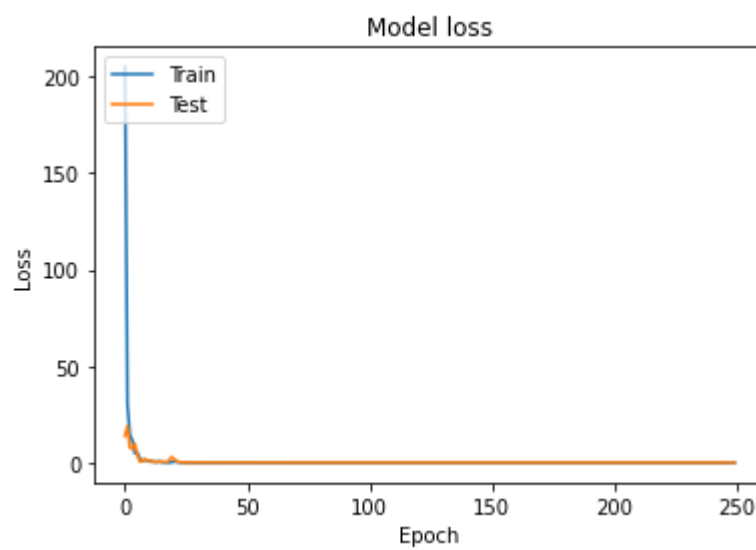
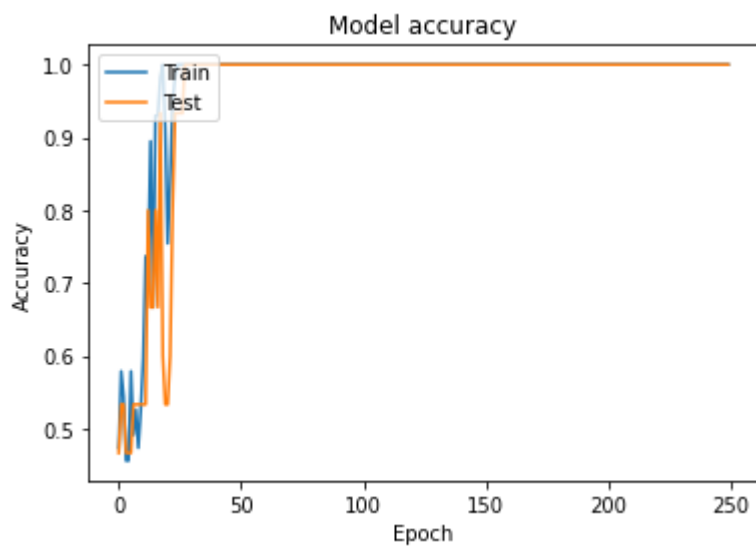
```
Epoch 244/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00244: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.091
4e-09 - accuracy: 1.0000 - val_loss: 0.0543 - val_accuracy: 1.0000
Epoch 245/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00245: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.091
4e-09 - accuracy: 1.0000 - val_loss: 0.0543 - val_accuracy: 1.0000
Epoch 246/250
10/57 [====>.....] - ETA: 0s - loss: 1.1921e-08
- accuracy: 1.0000
Epoch 00246: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.091
4e-09 - accuracy: 1.0000 - val_loss: 0.0542 - val_accuracy: 1.0000
Epoch 247/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00247: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.091
4e-09 - accuracy: 1.0000 - val_loss: 0.0542 - val_accuracy: 1.0000
Epoch 248/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00248: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.091
4e-09 - accuracy: 1.0000 - val_loss: 0.0542 - val_accuracy: 1.0000
Epoch 249/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00249: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.091
4e-09 - accuracy: 1.0000 - val_loss: 0.0543 - val_accuracy: 1.0000
Epoch 250/250
10/57 [====>.....] - ETA: 0s - loss: 0.0000e+00
- accuracy: 1.0000
Epoch 00250: val_accuracy did not improve from 1.00000
57/57 [=====] - 0s 1ms/sample - loss: 2.091
4e-09 - accuracy: 1.0000 - val_loss: 0.0543 - val_accuracy: 1.0000
Training completed in time: 0:00:24.847637
```


Plot accuracies and losses

In [25]:

```
# Plot training & validation accuracy values
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='upper left')
plt.show()

# Plot training & validation loss values
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('Model loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='upper left')
plt.show()
```



Test the model

Here we will review the accuracy of the model on both the training and test data sets.

In [26]:

```
# Evaluating the model on the training and testing set
score = model.evaluate(x_train, y_train, verbose=0)
print("Training Accuracy: ", score[1])

score = model.evaluate(x_test, y_test, verbose=0)
print("Testing Accuracy: ", score[1])
```

Training Accuracy: 1.0

Testing Accuracy: 1.0

In [27]:

```
preds = model.predict(x_test) # label scores

classpreds = np.argmax(preds, axis=1) # predicted classes

y_testclass = np.argmax(y_test, axis=1) # true classes

n_classes=2 # number of classes
```

In [28]:

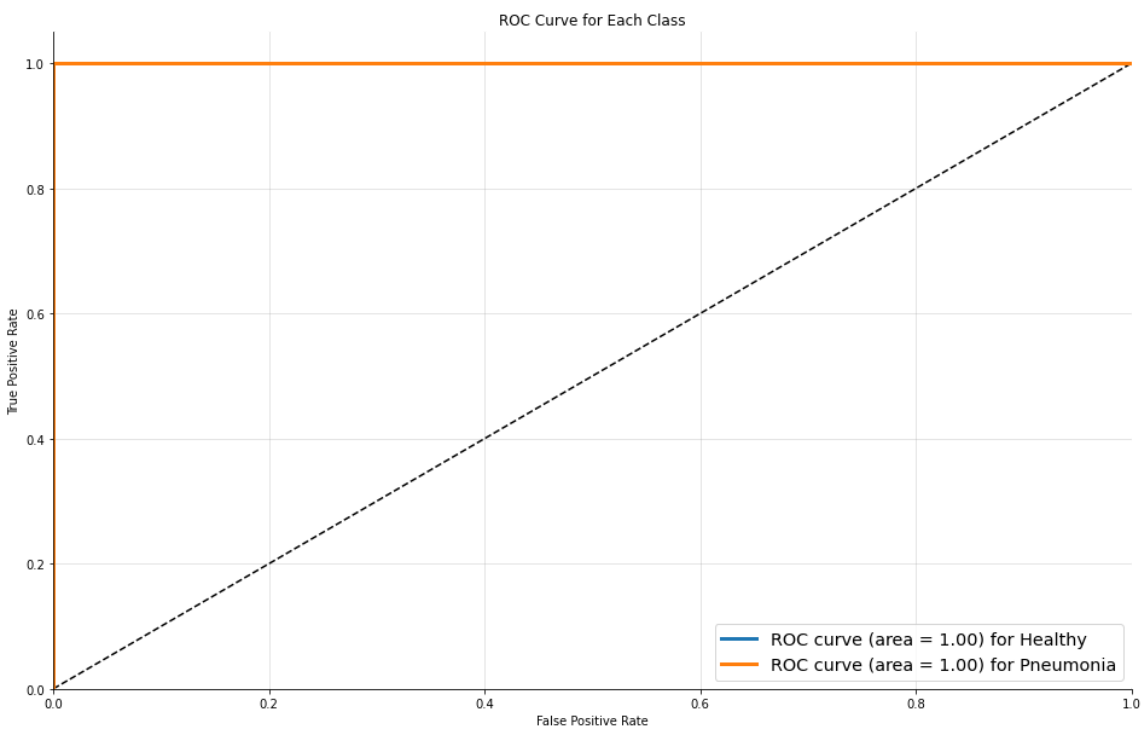
```
# Compute ROC curve and ROC area for each class
fpr = dict()
tpr = dict()
roc_auc = dict()
for i in range(n_classes):
    fpr[i], tpr[i], _ = roc_curve(y_test[:, i], preds[:, i])
    roc_auc[i] = auc(fpr[i], tpr[i])
```

In [29]:

```
c_names = ['Bronchiectasis', 'Bronchiolitis', 'COPD', 'Healthy', 'Pneumonia', 'U
RTI']
c_names = ['Healthy', 'Pneumonia']
```


In [30]:

```
# Plot ROC curves
fig, ax = plt.subplots(figsize=(16, 10))
ax.plot([0, 1], [0, 1], 'k--')
ax.set_xlim([0.0, 1.0])
ax.set_ylim([0.0, 1.05])
ax.set_xlabel('False Positive Rate')
ax.set_ylabel('True Positive Rate')
ax.set_title('ROC Curve for Each Class')
for i in range(n_classes):
    ax.plot(fpr[i], tpr[i], linewidth=3, label='ROC curve (area = %0.2f) for %s'
% (roc_auc[i], c_names[i]))
ax.legend(loc="best", fontsize='x-large')
ax.grid(alpha=.4)
sns.despine()
plt.show()
```



In [31]:

```
# Classification Report
print(classification_report(y_testclass, classpreds, target_names=c_names))
```

	precision	recall	f1-score	support
Healthy	1.00	1.00	1.00	7
Pneumonia	1.00	1.00	1.00	8
accuracy			1.00	15
macro avg	1.00	1.00	1.00	15
weighted avg	1.00	1.00	1.00	15

In [32]:

```
# Confusion Matrix
print(confusion_matrix(y_testclass, classpreds))
```

```
[[7 0]
 [0 8]]
```

In [33]:

```
import itertools
def plot_confusion_matrix(cm, unique_labels, show=True, output=None,
                          title='Confusion matrix', cmap=plt.cm.Oranges):
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(cm.shape[1])
    plt.xticks(tick_marks, rotation=45)
    ax = plt.gca()
    ax.set_xticklabels((ax.get_xticks() + 1).astype(str))
    plt.yticks(tick_marks)

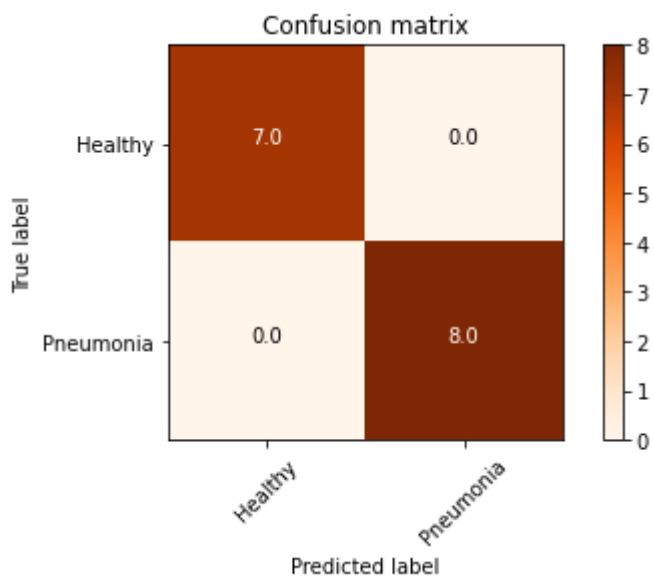
    ax.set_xticklabels(unique_labels)
    ax.set_yticklabels(unique_labels)

    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, format(cm[i, j], '.1f'),
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
    if show:
        plt.show()
    if output is not None:
        plt.savefig(output)
    plt.close()
    return output
```

In [34]:

```
plot_confusion_matrix(confusion_matrix(y_testclass, classpreds), unique_labels=[  
    "Healthy", "Pneumonia"])
```



In []: