```python
import numpy as np
import matplotlib.pyplot as plt
from keras.models import Sequential
from keras.layers import Dense
from keras.optimizers.legacy import Adam
from keras.utils import to_categorical
from keras.layers import Dropout, Flatten
from keras.layers import Conv2D, MaxPooling2D
import cv2
from sklearn.model_selection import train_test_split
import pickle
import os
import pandas as pd
import random
from keras.preprocessing.image import ImageDataGenerator
import tensorflow as tf
import h5py
```

```
2023-11-10 09:06:22.330206: I tensorflow/core/util/port.cc:110] oneDNN
custom operations are on. You may see slightly different numerical
results due to floating-point round-off errors from different
computation orders. To turn them off, set the environment variable
`TF_ENABLE_ONEDNN_OPTS=0`.
2023-11-10 09:06:22.388072: I
tensorflow/core/platform/cpu_feature_guard.cc:182] This TensorFlow
binary is optimized to use available CPU instructions in performance-
critical operations.
To enable the following instructions: AVX2 AVX512F AVX512_VNNI FMA, in
other operations, rebuild TensorFlow with the appropriate compiler
flags.
2023-11-10 09:06:23.290956: W
tensorflow/compiler/tf2tensorrt/utils/py_utils.cc:38] TF-TRT Warning:
Could not find TensorRT
```

```python
path = "FaceShape_Dataset"
labelFile = 'FaceLabels.csv'
batch_size_val = 50
steps_per_epoch_val = 1000
epochs_val = 30
imageDimesions = (32, 32, 3)
testRatio = 0.2
validationRatio = 0.2

count = 0
images = []
classNo = []
myList = os.listdir(path)
print("Total Classes Detected:", len(myList))
noOfClasses = len(myList)
```

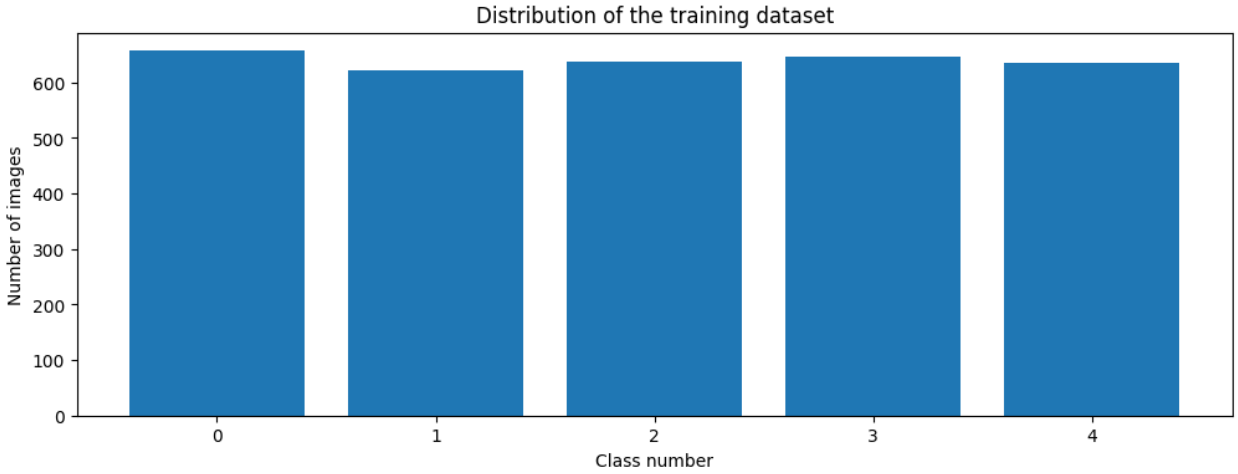
```
print("Importing Classes.....")
for x in range(0, len(myList)):
    myPicList = os.listdir(path + "/" + str(count))
    for y in myPicList:
        try:
            curImg = cv2.imread(path + "/" + str(count) + "/" + y)

            dim = (32, 32)

            resized = cv2.resize(curImg, dim,
interpolation=cv2.INTER_AREA)

            images.append(resized)
            classNo.append(count)

        except Exception as e:
            print(str(e))
    print(count, end=" ")
    count += 1
print(" ")
images = np.array(images)
classNo = np.array(classNo)

X_train, X_test, y_train, y_test = train_test_split(images, classNo,
test_size=testRatio)
X_train, X_validation, y_train, y_validation =
train_test_split(X_train, y_train, test_size=validationRatio)
```

```
Total Classes Detected: 5
Importing Classes.....

Premature end of JPEG file

OpenCV(4.8.1) /io/opencv/modules/imgproc/src/resize.cpp:4062: error:
(-215:Assertion failed) !ssize.empty() in function 'resize'

0 OpenCV(4.8.1) /io/opencv/modules/imgproc/src/resize.cpp:4062: error:
(-215:Assertion failed) !ssize.empty() in function 'resize'

1 2 3

Premature end of JPEG file

4
```

```
print("Data Shapes")
print("Train", end="");
print(X_train.shape, y_train.shape)
print("Validation", end="");
print(X_validation.shape, y_validation.shape)
print("Test", end="");
print(X_test.shape, y_test.shape)

data = pd.read_csv(labelFile)
print("data shape ", data.shape, type(data))

num_of_samples = []
cols = 5
num_classes = noOfClasses
fig, axs = plt.subplots(nrows=num_classes, ncols=cols, figsize=(5,
300))
fig.tight_layout()
for i in range(cols):
    for j, row in data.iterrows():
        x_selected = X_train[y_train == j]
        axs[j][i].imshow(x_selected[random.randint(0, len(x_selected)
- 1), :, :], cmap=plt.get_cmap("gray"))
        axs[j][i].axis("off")
        if i == 2:
            axs[j][i].set_title(str(j) + "-" + row["Name"])
            num_of_samples.append(len(x_selected))

print(num_of_samples)
plt.figure(figsize=(12, 4))
plt.bar(range(0, num_classes), num_of_samples)
plt.title("Distribution of the training dataset")
plt.xlabel("Class number")
plt.ylabel("Number of images")
plt.show()
```

```
Data Shapes
Train(3199, 32, 32, 3) (3199,)
Validation(800, 32, 32, 3) (800,)
Test(1000, 32, 32, 3) (1000,)
data shape  (5, 2) <class 'pandas.core.frame.DataFrame'>
[657, 622, 638, 646, 636]
```

0-Face Shape Heart



```python
import logging

# Set up the logging configuration
logging.basicConfig(level=logging.INFO)
logger = logging.getLogger(__name__)

def grayscale(img):
    img = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    return img

def equalize(img):
    img = cv2.equalizeHist(img)
    return img

def preprocessing(img):
    img = grayscale(img)
    img = equalize(img)
    img = img / 255
    return img

# Preprocess the images and log the progress
def preprocess_images(images, set_name):
    preprocessed_images = []
    for i, img in enumerate(images):
        # logger.info(f"Preprocessing {set_name} image {i +
1}/{len(images)}")
        preprocessed_img = preprocessing(img)
        preprocessed_images.append(preprocessed_img)
    return np.array(preprocessed_images)

print("Preprocessing started for X_TRAIN")
X_train = preprocess_images(X_train, "training")
```

```
print("Preprocessing ended for X_TRAIN")

print("Preprocessing started for X_VALIDATION")
X_validation = preprocess_images(X_validation, "validation")
print("Preprocessing ended for X_VALIDATION")

print("Preprocessing started for X_TEST")
X_test = preprocess_images(X_test, "test")
print("Preprocessing ended for X_TEST")

print("Preprocessing Done")


# cv2.imshow("GrayScale Images",
#             X_train[random.randint(0, len(X_train) - 1)])
# cv2.waitKey(0)  # Wait indefinitely until a key is pressed
# cv2.destroyAllWindows()  # Close all OpenCV windows

X_train = X_train.reshape(X_train.shape[0], X_train.shape[1],
X_train.shape[2], 1)
X_validation = X_validation.reshape(X_validation.shape[0],
X_validation.shape[1], X_validation.shape[2], 1)
X_test = X_test.reshape(X_test.shape[0], X_test.shape[1],
X_test.shape[2], 1)

print("Reshape Done")
```

```
Preprocessing started for X_TRAIN
Preprocessing ended for X_TRAIN
Preprocessing started for X_VALIDATION
Preprocessing ended for X_VALIDATION
Preprocessing started for X_TEST
Preprocessing ended for X_TEST
Preprocessing Done
Reshape Done
```

```
dataGen = ImageDataGenerator(width_shift_range=0.1,
                             # 0.1 = 10%     IF MORE THAN 1 E.G 10
THEN IT REFFERS TO NO. OF  PIXELS EG 10 PIXELS
                             height_shift_range=0.1,
                             zoom_range=0.2,  # 0.2 MEANS CAN GO FROM
0.8 TO 1.2
                             shear_range=0.1,  # MAGNITUDE OF SHEAR
ANGLE
                             rotation_range=10)  # DEGREES

dataGen.fit(X_train)

batches = dataGen.flow(X_train, y_train,
                       batch_size=20)
```

```
X_batch, y_batch = next(batches)

fig, axs = plt.subplots(1, 15, figsize=(20, 5))
fig.tight_layout()

for i in range(15):
    axs[i].imshow(X_batch[i].reshape(imageDimesions[0],
imageDimesions[1]))
    axs[i].axis('off')
plt.show()

y_train = to_categorical(y_train, noOfClasses)
y_validation = to_categorical(y_validation, noOfClasses)
y_test = to_categorical(y_test, noOfClasses)


def myModel():
    no_Of_Filters = 60
    size_of_Filter = (5, 5)

    size_of_Filter2 = (3, 3)
    size_of_pool = (2, 2)
    no_Of_Nodes = 500
    model = Sequential()
    model.add((Conv2D(no_Of_Filters, size_of_Filter,
input_shape=(imageDimesions[0], imageDimesions[1], 1),
                      activation='relu')))
    model.add((Conv2D(no_Of_Filters, size_of_Filter,
activation='relu')))
    model.add(MaxPooling2D(pool_size=size_of_pool))

    model.add((Conv2D(no_Of_Filters // 2, size_of_Filter2,
activation='relu')))
    model.add((Conv2D(no_Of_Filters // 2, size_of_Filter2,
activation='relu')))
    model.add(MaxPooling2D(pool_size=size_of_pool))
    model.add(Dropout(0.5))

    model.add(Flatten())
    model.add(Dense(no_Of_Nodes, activation='relu'))
    model.add(Dropout(0.5))
    model.add(Dense(noOfClasses, activation='softmax'))

    model.compile(Adam(learning_rate=0.001),
loss='categorical_crossentropy', metrics=['accuracy'])
    return model


model = myModel()
history = model.fit(X_train, y_train, epochs=epochs_val,
steps_per_epoch=len(X_train)//batch_size_val,
batch_size=batch_size_val,
                    validation_data=(X_validation, y_validation),
shuffle=1)
```

```
Epoch 1/30

2023-11-10 09:07:09.246911: I
tensorflow/compiler/xla/stream_executor/cuda/cuda_gpu_executor.cc:995]
successful NUMA node read from SysFS had negative value (-1), but
there must be at least one NUMA node, so returning NUMA node zero. See
more at
https://github.com/torvalds/linux/blob/v6.0/Documentation/ABI/testing/
sysfs-bus-pci#L344-L355
2023-11-10 09:07:09.271298: I
tensorflow/compiler/xla/stream_executor/cuda/cuda_gpu_executor.cc:995]
successful NUMA node read from SysFS had negative value (-1), but
there must be at least one NUMA node, so returning NUMA node zero. See
more at
https://github.com/torvalds/linux/blob/v6.0/Documentation/ABI/testing/
sysfs-bus-pci#L344-L355
2023-11-10 09:07:09.271528: I
tensorflow/compiler/xla/stream_executor/cuda/cuda_gpu_executor.cc:995]
successful NUMA node read from SysFS had negative value (-1), but
there must be at least one NUMA node, so returning NUMA node zero. See
more at
https://github.com/torvalds/linux/blob/v6.0/Documentation/ABI/testing/
sysfs-bus-pci#L344-L355
2023-11-10 09:07:09.274112: I
tensorflow/compiler/xla/stream_executor/cuda/cuda_gpu_executor.cc:995]
successful NUMA node read from SysFS had negative value (-1), but
there must be at least one NUMA node, so returning NUMA node zero. See
more at
https://github.com/torvalds/linux/blob/v6.0/Documentation/ABI/testing/
sysfs-bus-pci#L344-L355
2023-11-10 09:07:09.274327: I
tensorflow/compiler/xla/stream_executor/cuda/cuda_gpu_executor.cc:995]
successful NUMA node read from SysFS had negative value (-1), but
there must be at least one NUMA node, so returning NUMA node zero. See
more at
https://github.com/torvalds/linux/blob/v6.0/Documentation/ABI/testing/
sysfs-bus-pci#L344-L355
2023-11-10 09:07:09.274617: I
tensorflow/compiler/xla/stream_executor/cuda/cuda_gpu_executor.cc:995]
successful NUMA node read from SysFS had negative value (-1), but
there must be at least one NUMA node, so returning NUMA node zero. See
```

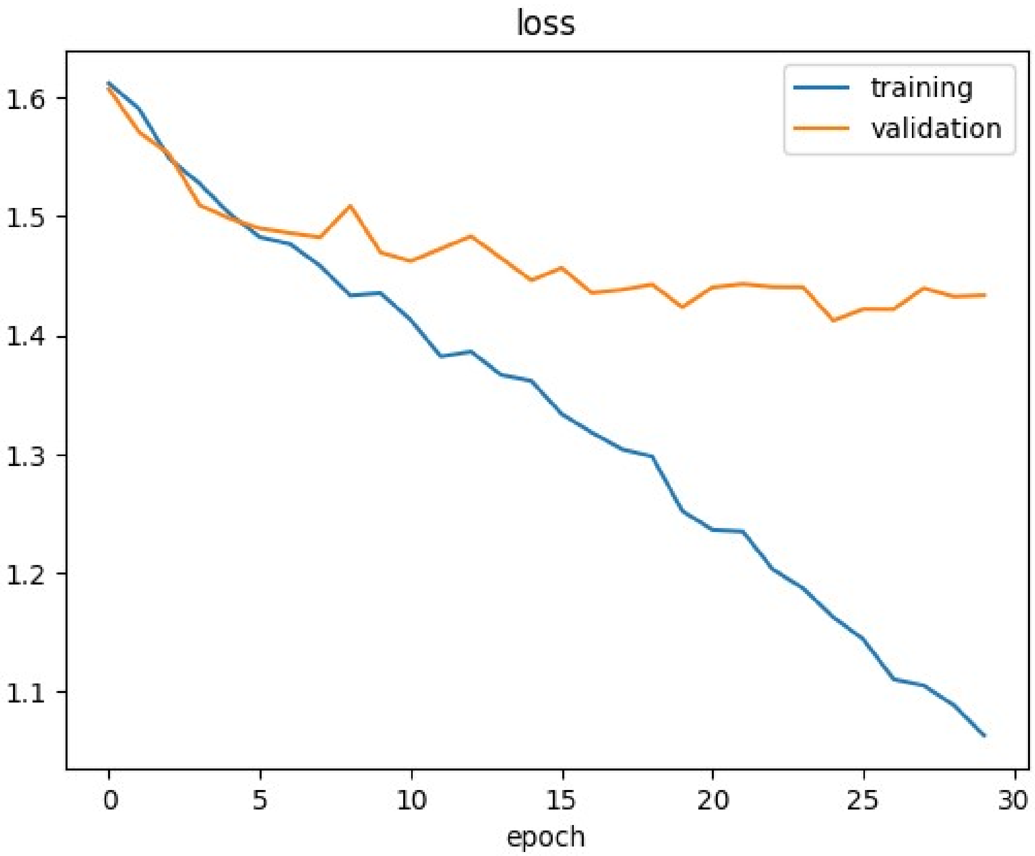
```
more at
https://github.com/torvalds/linux/blob/v6.0/Documentation/ABI/testing/
sysfs-bus-pci#L344-L355
2023-11-10 09:07:09.340115: I
tensorflow/compiler/xla/stream_executor/cuda/cuda_gpu_executor.cc:995]
successful NUMA node read from SysFS had negative value (-1), but
there must be at least one NUMA node, so returning NUMA node zero. See
more at
https://github.com/torvalds/linux/blob/v6.0/Documentation/ABI/testing/
sysfs-bus-pci#L344-L355
2023-11-10 09:07:09.340321: I
tensorflow/compiler/xla/stream_executor/cuda/cuda_gpu_executor.cc:995]
successful NUMA node read from SysFS had negative value (-1), but
there must be at least one NUMA node, so returning NUMA node zero. See
more at
https://github.com/torvalds/linux/blob/v6.0/Documentation/ABI/testing/
sysfs-bus-pci#L344-L355
2023-11-10 09:07:09.340465: I
tensorflow/compiler/xla/stream_executor/cuda/cuda_gpu_executor.cc:995]
successful NUMA node read from SysFS had negative value (-1), but
there must be at least one NUMA node, so returning NUMA node zero. See
more at
https://github.com/torvalds/linux/blob/v6.0/Documentation/ABI/testing/
sysfs-bus-pci#L344-L355
2023-11-10 09:07:09.340586: I
tensorflow/core/common_runtime/gpu/gpu_device.cc:1639] Created
device /job:localhost/replica:0/task:0/device:GPU:0 with 5665 MB
memory:  -> device: 0, name: NVIDIA GeForce RTX 3070 Laptop GPU, pci
bus id: 0000:01:00.0, compute capability: 8.6
2023-11-10 09:07:09.754223: E
tensorflow/core/grappler/optimizers/meta_optimizer.cc:954] layout
failed: INVALID_ARGUMENT: Size of values 0 does not match size of
permutation 4 @ fanin shape insequential/dropout/dropout/SelectV2-2-
TransposeNHWCToNCHW-LayoutOptimizer
2023-11-10 09:07:09.804862: I
tensorflow/compiler/xla/stream_executor/cuda/cuda_dnn.cc:432] Loaded
cuDNN version 8600
2023-11-10 09:07:09.954383: I
tensorflow/compiler/xla/stream_executor/cuda/cuda_blas.cc:606]
TensorFloat-32 will be used for the matrix multiplication. This will
only be logged once.

63/63 [==============================] - 1s 6ms/step - loss: 1.6117 -
accuracy: 0.2010 - val_loss: 1.6071 - val_accuracy: 0.2450
Epoch 2/30
63/63 [==============================] - 1s 4ms/step - loss: 1.5903 -
accuracy: 0.2458 - val_loss: 1.5707 - val_accuracy: 0.2450
Epoch 3/30
63/63 [==============================] - 0s 4ms/step - loss: 1.5484 -
accuracy: 0.3036 - val_loss: 1.5522 - val_accuracy: 0.3100
```

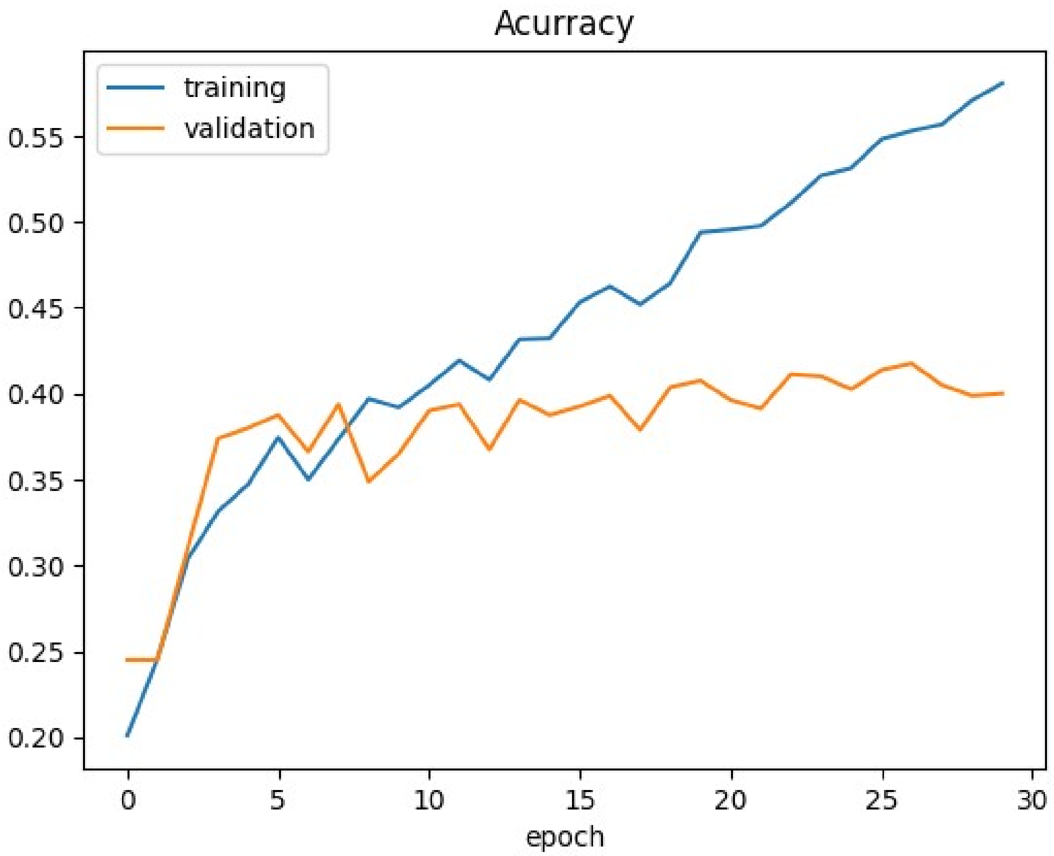
```
Epoch 4/30
63/63 [==============================] - 0s 4ms/step - loss: 1.5276 -
accuracy: 0.3312 - val_loss: 1.5094 - val_accuracy: 0.3738
Epoch 5/30
63/63 [==============================] - 0s 4ms/step - loss: 1.5021 -
accuracy: 0.3471 - val_loss: 1.4981 - val_accuracy: 0.3800
Epoch 6/30
63/63 [==============================] - 0s 4ms/step - loss: 1.4825 -
accuracy: 0.3744 - val_loss: 1.4898 - val_accuracy: 0.3875
Epoch 7/30
63/63 [==============================] - 0s 4ms/step - loss: 1.4767 -
accuracy: 0.3500 - val_loss: 1.4859 - val_accuracy: 0.3663
Epoch 8/30
63/63 [==============================] - 0s 4ms/step - loss: 1.4583 -
accuracy: 0.3735 - val_loss: 1.4823 - val_accuracy: 0.3938
Epoch 9/30
63/63 [==============================] - 0s 4ms/step - loss: 1.4332 -
accuracy: 0.3970 - val_loss: 1.5088 - val_accuracy: 0.3487
Epoch 10/30
63/63 [==============================] - 0s 4ms/step - loss: 1.4353 -
accuracy: 0.3919 - val_loss: 1.4696 - val_accuracy: 0.3650
Epoch 11/30
63/63 [==============================] - 0s 4ms/step - loss: 1.4128 -
accuracy: 0.4049 - val_loss: 1.4622 - val_accuracy: 0.3900
Epoch 12/30
63/63 [==============================] - 0s 4ms/step - loss: 1.3820 -
accuracy: 0.4192 - val_loss: 1.4727 - val_accuracy: 0.3938
Epoch 13/30
63/63 [==============================] - 0s 4ms/step - loss: 1.3861 -
accuracy: 0.4081 - val_loss: 1.4832 - val_accuracy: 0.3675
Epoch 14/30
63/63 [==============================] - 0s 4ms/step - loss: 1.3665 -
accuracy: 0.4316 - val_loss: 1.4647 - val_accuracy: 0.3963
Epoch 15/30
63/63 [==============================] - 0s 4ms/step - loss: 1.3615 -
accuracy: 0.4322 - val_loss: 1.4461 - val_accuracy: 0.3875
Epoch 16/30
63/63 [==============================] - 0s 4ms/step - loss: 1.3337 -
accuracy: 0.4532 - val_loss: 1.4566 - val_accuracy: 0.3925
Epoch 17/30
63/63 [==============================] - 0s 4ms/step - loss: 1.3181 -
accuracy: 0.4624 - val_loss: 1.4355 - val_accuracy: 0.3988
Epoch 18/30
63/63 [==============================] - 0s 4ms/step - loss: 1.3041 -
accuracy: 0.4519 - val_loss: 1.4381 - val_accuracy: 0.3787
Epoch 19/30
63/63 [==============================] - 0s 4ms/step - loss: 1.2979 -
accuracy: 0.4643 - val_loss: 1.4426 - val_accuracy: 0.4038
Epoch 20/30
```

```
63/63 [==============================] - 0s 4ms/step - loss: 1.2521 -
accuracy: 0.4938 - val_loss: 1.4235 - val_accuracy: 0.4075
Epoch 21/30
63/63 [==============================] - 0s 4ms/step - loss: 1.2363 -
accuracy: 0.4954 - val_loss: 1.4402 - val_accuracy: 0.3963
Epoch 22/30
63/63 [==============================] - 0s 4ms/step - loss: 1.2350 -
accuracy: 0.4976 - val_loss: 1.4430 - val_accuracy: 0.3913
Epoch 23/30
63/63 [==============================] - 0s 4ms/step - loss: 1.2030 -
accuracy: 0.5110 - val_loss: 1.4406 - val_accuracy: 0.4112
Epoch 24/30
63/63 [==============================] - 0s 4ms/step - loss: 1.1870 -
accuracy: 0.5268 - val_loss: 1.4404 - val_accuracy: 0.4100
Epoch 25/30
63/63 [==============================] - 0s 4ms/step - loss: 1.1629 -
accuracy: 0.5313 - val_loss: 1.4124 - val_accuracy: 0.4025
Epoch 26/30
63/63 [==============================] - 0s 4ms/step - loss: 1.1441 -
accuracy: 0.5481 - val_loss: 1.4219 - val_accuracy: 0.4137
Epoch 27/30
63/63 [==============================] - 0s 4ms/step - loss: 1.1107 -
accuracy: 0.5529 - val_loss: 1.4217 - val_accuracy: 0.4175
Epoch 28/30
63/63 [==============================] - 0s 4ms/step - loss: 1.1053 -
accuracy: 0.5567 - val_loss: 1.4395 - val_accuracy: 0.4050
Epoch 29/30
63/63 [==============================] - 0s 4ms/step - loss: 1.0887 -
accuracy: 0.5707 - val_loss: 1.4324 - val_accuracy: 0.3988
Epoch 30/30
63/63 [==============================] - 0s 5ms/step - loss: 1.0633 -
accuracy: 0.5805 - val_loss: 1.4334 - val_accuracy: 0.4000

# STORE THE MODEL AS A PICKLE OBJECT
# model.save('faceshape_model_final.h5')

print(model.summary())

plt.figure(1)
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.legend(['training', 'validation'])
plt.title('loss')
plt.xlabel('epoch')
plt.figure(2)
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.legend(['training', 'validation'])
plt.title('Acurracy')
plt.xlabel('epoch')
```

```python
plt.show()
score = model.evaluate(X_test, y_test, verbose=0)
print('Test Score:', score[0])
print('Test Accuracy:', score[1])



cv2.waitKey(0)
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 conv2d (Conv2D)             (None, 28, 28, 60)        1560      
                                                                 
 conv2d_1 (Conv2D)           (None, 24, 24, 60)        90060     
                                                                 
 max_pooling2d (MaxPooling2  (None, 12, 12, 60)        0         
 D)                                                              
                                                                 
 conv2d_2 (Conv2D)           (None, 10, 10, 30)        16230     
                                                                 
 conv2d_3 (Conv2D)           (None, 8, 8, 30)          8130      
                                                                 
 max_pooling2d_1 (MaxPoolin  (None, 4, 4, 30)          0         
 g2D)                                                            
                                                                 
 dropout (Dropout)           (None, 4, 4, 30)          0         
                                                                 
 flatten (Flatten)           (None, 480)               0         
                                                                 
 dense (Dense)               (None, 500)               240500    
                                                                 
 dropout_1 (Dropout)         (None, 500)               0         
                                                                 
 dense_1 (Dense)             (None, 5)                 2505      
                                                                 
=================================================================
Total params: 358985 (1.37 MB)
Trainable params: 358985 (1.37 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
None
```


loss
training
validation
1.6
1.5
1.4
1.3
1.2
1.1
0
5
10
15
20
25
30
epoch



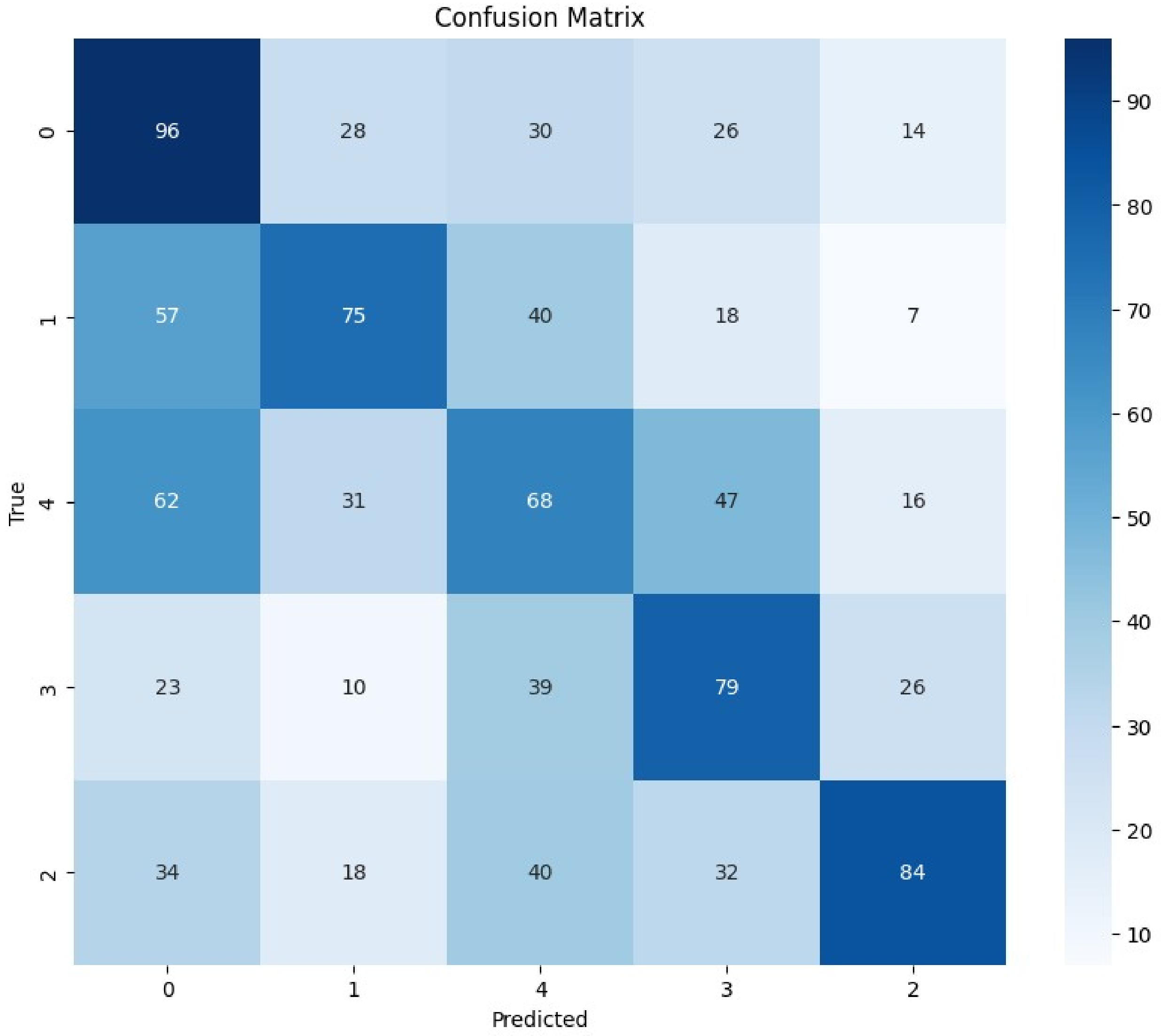
```
Test Score: 1.4330676794052124
Test Accuracy: 0.4020000100135803

-1
```

```python
from keras.utils import plot_model

plot_model(model, to_file='model_plot.png', show_shapes=True,
show_layer_names=True)
```

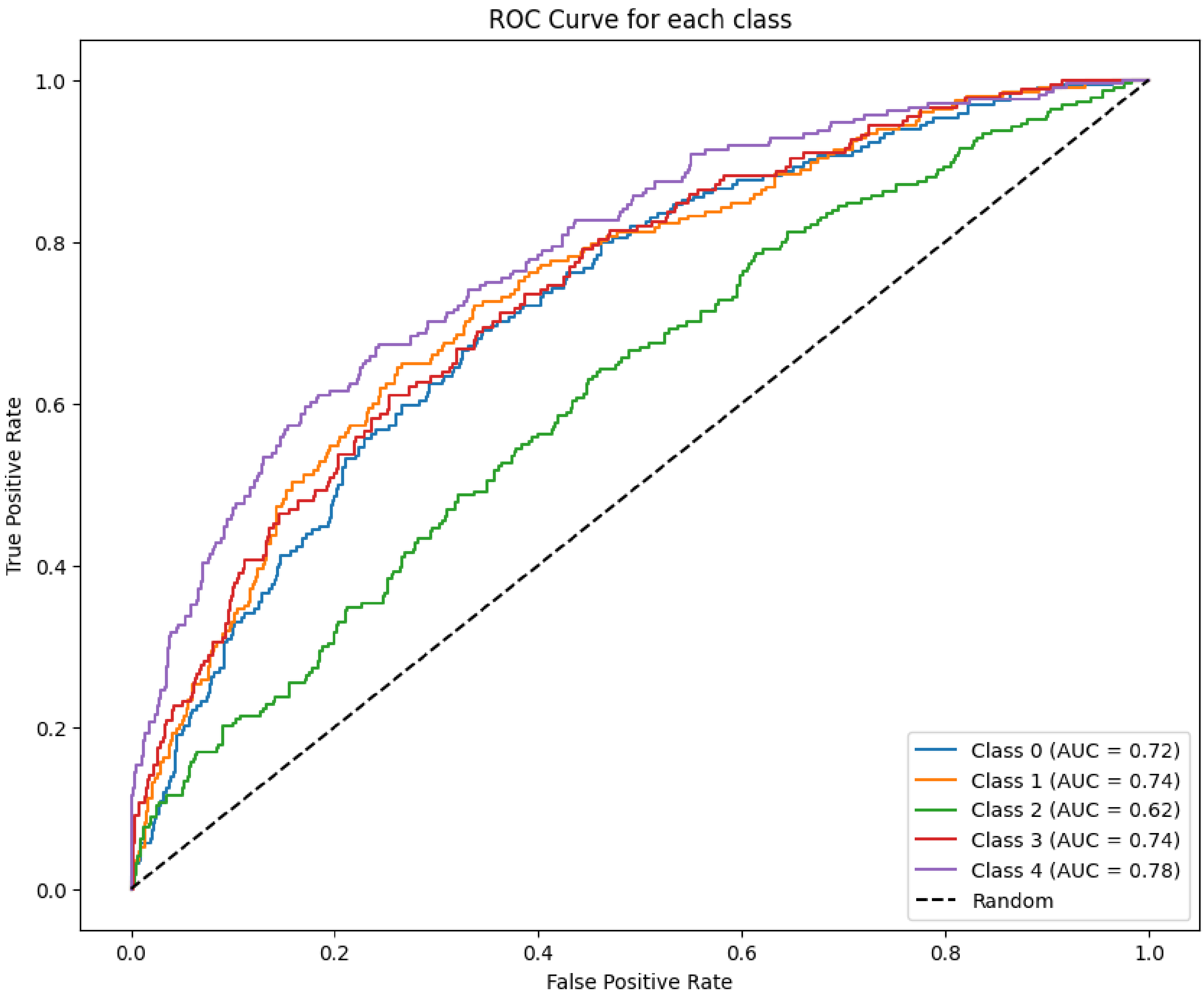
```
You must install pydot (`pip install pydot`) and install graphviz (see
instructions at https://graphviz.gitlab.io/download/) for plot_model
to work.
```

```python
from sklearn.metrics import confusion_matrix
import seaborn as sns
import numpy as np

# Convert one-hot encoded labels back to class labels
y_test_classes = np.argmax(y_test, axis=1)

# Predict on the test set
y_pred = model.predict(X_test)
y_pred_classes = np.argmax(y_pred, axis=1)
```

```
# Generate confusion matrix
conf_mat = confusion_matrix(y_test_classes, y_pred_classes)

# Plot the confusion matrix
plt.figure(figsize=(10, 8))
sns.heatmap(conf_mat, annot=True, fmt='d', cmap='Blues',
xticklabels=myList, yticklabels=myList)
plt.title('Confusion Matrix')
plt.xlabel('Predicted')
plt.ylabel('True')
plt.show()

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



```python
from sklearn.metrics import roc_curve, auc


# Compute ROC curve and ROC area for each class
fpr = dict()
tpr = dict()
roc_auc = dict()

for i in range(noOfClasses):
    fpr[i], tpr[i], _ = roc_curve(y_test[:, i], y_pred[:, i])
    roc_auc[i] = auc(fpr[i], tpr[i])

# Plot ROC curve
plt.figure(figsize=(10, 8))
for i in range(noOfClasses):
    plt.plot(fpr[i], tpr[i], label=f'Class {i} (AUC =
{roc_auc[i]:.2f})')

plt.plot([0, 1], [0, 1], 'k--', label='Random')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve for each class')
plt.legend(loc="lower right")
plt.show()
```


ROC Curve for each class
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.2
0.4
0.6
0.8
1.0
Class 0 (AUC = 0.72)
Class 1 (AUC = 0.74)
Class 2 (AUC = 0.62)
Class 3 (AUC = 0.74)
Class 4 (AUC = 0.78)
Random