In [ ]:
```
# This Python 3 environment comes with many helpful analytics libraries installe
# It is defined by the kaggle/python Docker image: https://github.com/kaggle/doc
# For example, here's several helpful packages to load

import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the read-only "../input/" directory
# For example, running this (by clicking run or pressing Shift+Enter) will list

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

# You can write up to 20GB to the current directory (/kaggle/working/) that gets
# You can also write temporary files to /kaggle/temp/, but they won't be saved o
```

In [ ]:
```
import pandas as pd
import numpy as np
```

In [ ]:
```
df=pd.read_csv("/kaggle/input/correct/labels.csv")
```

In [ ]:
```
df.head()
```

Out[ ]:

	image_name	lables
0	1.jpg	0
1	2.jpg	0
2	3.jpg	0
3	IMG_20240805_131928561_HDR.jpg	0
4	IMG_20240805_131930233.jpg	0

In [ ]:
```
!pip install -q tensorflowjs
```

```
/opt/conda/lib/python3.10/pty.py:89: RuntimeWarning: os.fork() was called. os.for
k() is incompatible with multithreaded code, and JAX is multithreaded, so this wi
ll likely lead to a deadlock.
  pid, fd = os.forkpty()
```

```
ERROR: pip's dependency resolver does not currently take into account all the pac
kages that are installed. This behaviour is the source of the following dependenc
y conflicts.
cudf 24.6.1 requires cubinlinker, which is not installed.
cudf 24.6.1 requires cupy-cuda11x>=12.0.0, which is not installed.
cudf 24.6.1 requires ptxcompiler, which is not installed.
cuml 24.6.1 requires cupy-cuda11x>=12.0.0, which is not installed.
dask-cudf 24.6.1 requires cupy-cuda11x>=12.0.0, which is not installed.
keras-cv 0.9.0 requires keras-core, which is not installed.
cudf 24.6.1 requires cuda-python<12.0a0,>=11.7.1, but you have cuda-python 12.5.0
which is incompatible.
distributed 2024.5.1 requires dask==2024.5.1, but you have dask 2024.7.0 which is
incompatible.
google-cloud-bigquery 2.34.4 requires packaging<22.0dev,>=14.3, but you have pack
aging 23.2 which is incompatible.
jupyterlab 4.2.3 requires jupyter-lsp>=2.0.0, but you have jupyter-lsp 1.5.1 whic
h is incompatible.
jupyterlab-lsp 5.1.0 requires jupyter-lsp>=2.0.0, but you have jupyter-lsp 1.5.1
which is incompatible.
libpysal 4.9.2 requires shapely>=2.0.1, but you have shapely 1.8.5.post1 which is
incompatible.
momepy 0.7.2 requires shapely>=2, but you have shapely 1.8.5.post1 which is incom
patible.
osmnx 1.9.3 requires shapely>=2.0, but you have shapely 1.8.5.post1 which is inco
mpatible.
pointpats 2.5.0 requires shapely>=2, but you have shapely 1.8.5.post1 which is in
compatible.
rapids-dask-dependency 24.6.0a0 requires dask==2024.5.1, but you have dask 2024.
7.0 which is incompatible.
spaghetti 1.7.6 requires shapely>=2.0.1, but you have shapely 1.8.5.post1 which i
s incompatible.
spopt 0.6.1 requires shapely>=2.0.1, but you have shapely 1.8.5.post1 which is in
compatible.
ydata-profiling 4.6.4 requires numpy<1.26,>=1.16.0, but you have numpy 1.26.4 whi
ch is incompatible.
```

In [ ]:
```
import pandas as pd
import cv2 as cv
import os
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPool2D, Flatten, Dense, Dropout,B
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.optimizers import Adam
from sklearn.metrics import accuracy_score
import tensorflowjs as tfjs
from sklearn.preprocessing import OneHotEncoder
from sklearn.utils import shuffle
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
import shutil
```

In [ ]:
```
# Read in Y labels from CSV

label_csv = '/kaggle/input/correct/labels.csv'
df_Y = pd.read_csv(label_csv)
```

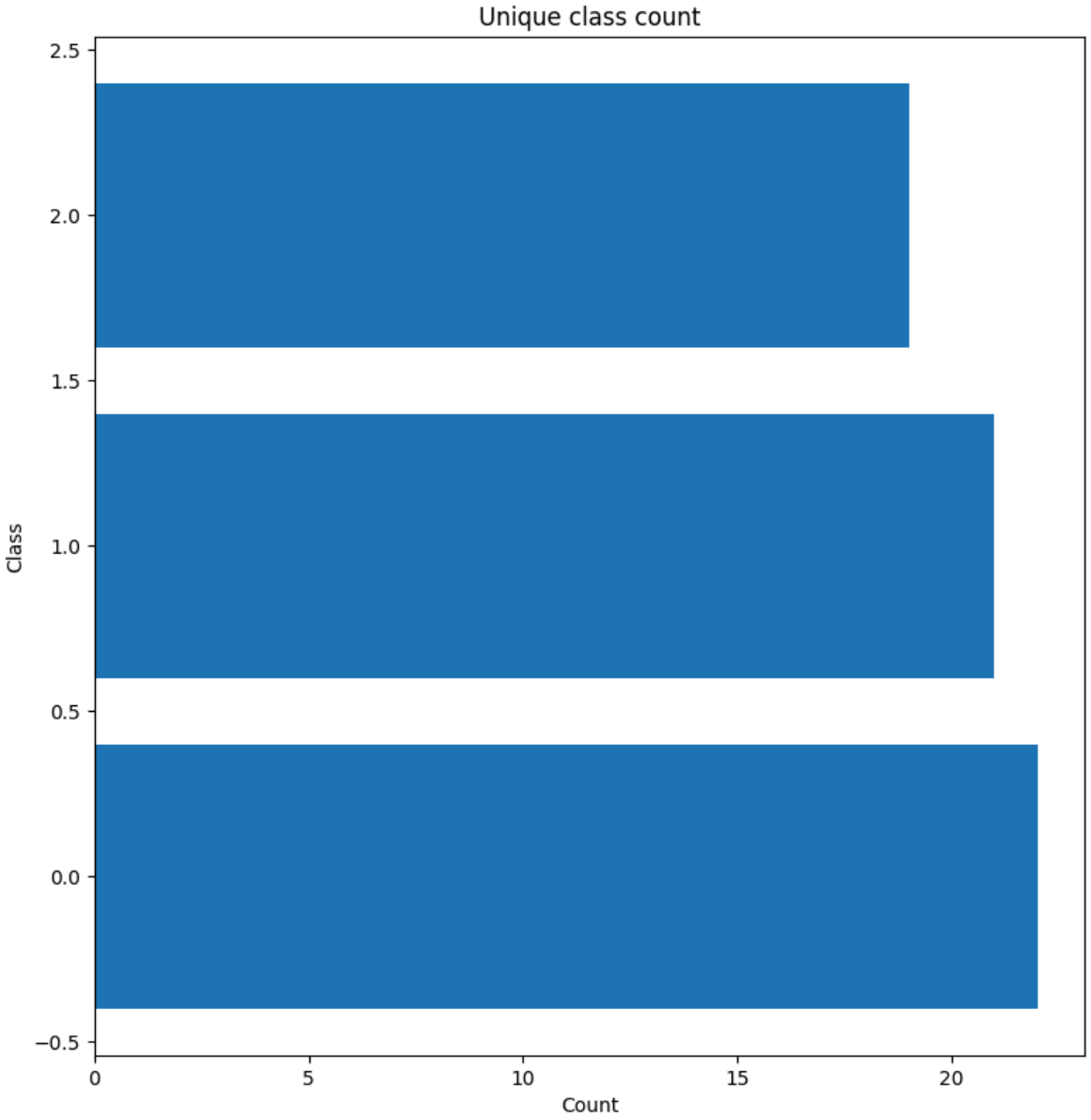
In [ ]:
```
# Read images and write with label to arrays

images_path = "/kaggle/input/hahahhahahahhaha/img"
images = []
labels = []
image_files = os.listdir(images_path)
image_files.sort()

for image_path in image_files:
    image = cv.imread(os.path.join(images_path, image_path)).astype('float32') #
    image = cv.resize(image, (64, 64)) # Resize to smaller size for faster train
    image = cv.cvtColor(image, cv.COLOR_BGR2GRAY) # Convert to greyscale for fas
    image /= 255.0 # Normalise data

    label_index = (image_path) # Get index into df_Y
    print(label_index)
    label = df_Y[df_Y['image_name'] == label_index].lables.values[0] # Get label

    # Write into arrays
    images.append(image)
    labels.append(label)
```

```
1.jpg
2.jpg
3.jpg
IMG_20240805_131928561_HDR.jpg
IMG_20240805_131930233.jpg
IMG_20240805_131931873_HDR.jpg
IMG_20240805_131933222_HDR.jpg
IMG_20240805_131935078_HDR.jpg
IMG_20240805_131937339.jpg
IMG_20240805_131938439.jpg
IMG_20240805_131939729.jpg
IMG_20240805_131940417.jpg
IMG_20240805_131941186_HDR.jpg
IMG_20240805_131942187_HDR.jpg
IMG_20240805_131943045_HDR.jpg
IMG_20240805_131944427_HDR.jpg
IMG_20240805_131945347_HDR.jpg
IMG_20240805_131948087_HDR.jpg
IMG_20240805_131950908_HDR.jpg
IMG_20240805_131952292_HDR.jpg
IMG_20240805_131953756_HDR.jpg
IMG_20240805_131955993_HDR.jpg
IMG_20240805_132028280_HDR.jpg
IMG_20240805_132030965_HDR.jpg
IMG_20240805_132034472_HDR.jpg
IMG_20240805_132035619_HDR.jpg
IMG_20240805_132037094_HDR.jpg
IMG_20240805_132040249_HDR.jpg
IMG_20240805_132043103_HDR.jpg
IMG_20240805_132044770_HDR.jpg
IMG_20240805_132046492_HDR.jpg
IMG_20240805_132048320_HDR.jpg
IMG_20240805_132049672_HDR.jpg
IMG_20240805_132050625_HDR.jpg
IMG_20240805_132052827_HDR.jpg
IMG_20240805_132054834_HDR.jpg
IMG_20240805_132058237_HDR.jpg
IMG_20240805_132059887_HDR.jpg
IMG_20240805_132100952_HDR.jpg
IMG_20240805_132117808_HDR.jpg
IMG_20240805_132119329_HDR.jpg
IMG_20240805_132121018_HDR.jpg
IMG_20240805_132150073_HDR.jpg
IMG_20240805_132151239_HDR.jpg
IMG_20240805_132158422_HDR.jpg
IMG_20240805_132200497_HDR.jpg
IMG_20240805_132206315_HDR.jpg
IMG_20240805_132212013.jpg
IMG_20240805_132216196_HDR.jpg
IMG_20240805_132217890_HDR.jpg
IMG_20240805_132220259_HDR.jpg
IMG_20240805_132227555_HDR.jpg
IMG_20240805_132229845_HDR.jpg
IMG_20240805_132241416.jpg
IMG_20240805_132434118_HDR.jpg
IMG_20240805_132436430.jpg
IMG_20240805_132444117_HDR.jpg
IMG_20240805_132453381_HDR.jpg
IMG_20240805_132509047_HDR.jpg
IMG_20240805_132524066_HDR.jpg
```

```
IMG_20240805_132528697_HDR.jpg
IMG_20240805_132530258_HDR.jpg
```

In [ ]:
```
# Convert to np arrays

images = np.array(images)
labels = np.array(labels)
```

In [ ]:
```
# Visualise the count for each class

unique_class, class_count = np.unique(labels, return_counts=True)

plt.figure(figsize=(8,8))
plt.barh(unique_class, class_count)
plt.tight_layout(pad=2.0)
plt.title("Unique class count")
plt.xlabel("Count")
plt.ylabel("Class")
plt.show()
```

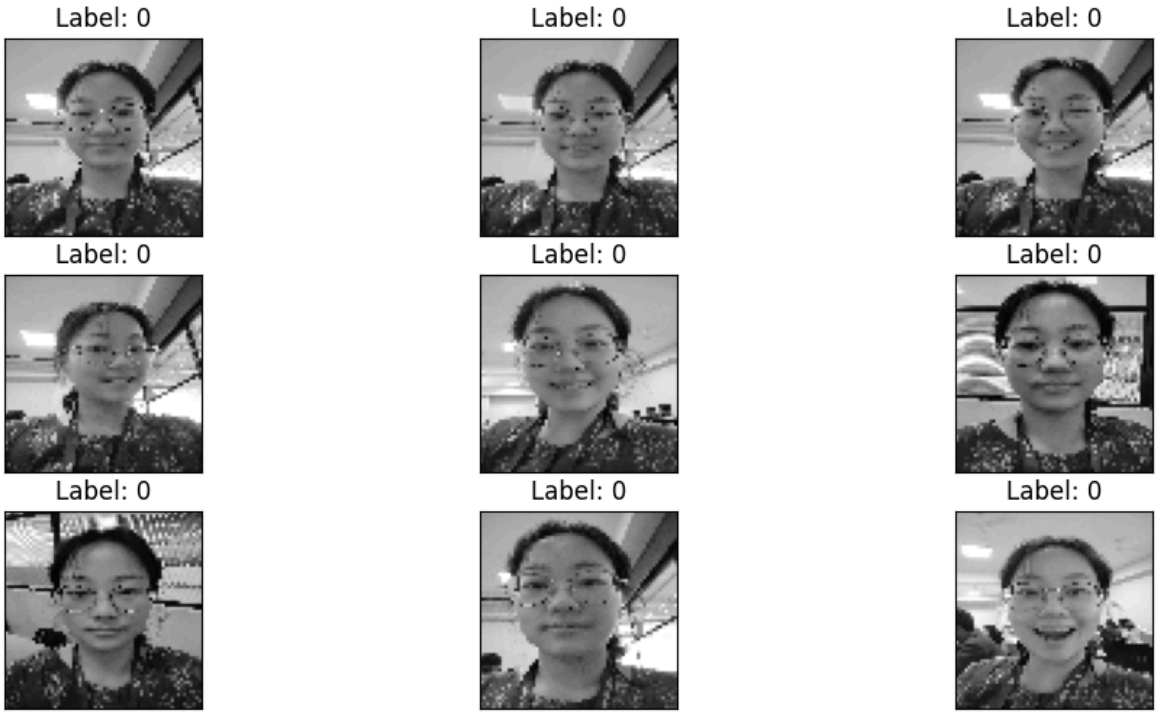


In [ ]:
```
# Add greyscale dimension for cnn

images = np.expand_dims(images, axis=-1)
```

In [ ]:
```
# One hot encode the labels

encoder = OneHotEncoder(sparse_output=False)
labels = encoder.fit_transform(labels.reshape(-1, 1))
```

In [ ]:
```
# Define a custom decoder

decoder = [str(i) for i in range(10)] + [chr(i) for i in range(65, 91)] + [chr(i
```

In [ ]:
```
# Plot 9 random images for visualisation

def display_images(rows, cols, images, labels, decoder):
    _, axes = plt.subplots(nrows = 3, ncols = 3, figsize=(12,6))

    for i, ax in enumerate(axes.flatten()):
        ax.imshow(images[i], cmap='gray')
        ax.set_xticks([])
        ax.set_yticks([])
        ax.set_title(f"Label: {decoder[np.where(labels[i]==1)[0][0]]}")

display_images(3, 3, images, labels, decoder)
```



In [ ]:
```
# Randomly shuffle the data

images, labels = shuffle(images, labels, random_state=0)
```

In [ ]:
```
# Split the data into train, test and validation sets (70, 15, 15)

X_train, X_temp, Y_train, Y_temp = train_test_split(images, labels, test_size=0.
X_val, X_test, Y_val, Y_test = train_test_split(X_temp, Y_temp, test_size=0.5, r
```

In [ ]:
```
# Define augmentation generator

datagen = ImageDataGenerator(
    rotation_range=15,
    width_shift_range=0.1,
```

```
    height_shift_range=0.2,
    zoom_range= 0.2,
    shear_range=0.2,
    fill_mode='nearest',
)
```

In [ ]:
```
# Load augmented data into arrays

augmented_arr_X = []
augmented_arr_Y = []
number_of_augmentation = 5

for i in range(len(X_train)):
    image_expanded = np.expand_dims(X_train[i], axis=0)
    aug_iter = datagen.flow(image_expanded, batch_size=1)
    augmented_images = [next(aug_iter)[0] for _ in range(number_of_augmentation)]
    augmented_arr_X.extend(augmented_images)
    augmented_arr_Y.extend([Y_train[i]] * number_of_augmentation)
```

In [ ]:
```
# Set augmented data up for training

X_train = np.array(augmented_arr_X)
Y_train = np.array(augmented_arr_Y)
```

In [ ]:
```
# Shuffle again

X_train, Y_train = shuffle(X_train, Y_train, random_state=0)
```

In [ ]:
```
# Display augmented images

display_images(3, 3, X_train, Y_train, decoder)
```

In [ ]:
```
# Define model

model = Sequential([
    Input(shape=(64, 64, 1)),
```

```
    Conv2D(512, (5, 5), activation='relu'),
    MaxPooling2D(pool_size=(2, 2)),

    Conv2D(256, (3, 3), activation='relu'),
    MaxPooling2D(pool_size=(2, 2)),

    Conv2D(256, (3, 3), activation='relu'),
    MaxPooling2D(pool_size=(2, 2)),

    Flatten(),

    Dense(512, activation='relu'),
    Dropout(0.1),

    Dense(1024, activation='relu'),

    Dense(512, activation='relu'),
    Dropout(0.1),

    Dense(256, activation='sigmoid'),

    Dense(3, activation='softmax')
])
```

In [ ]:
```
# Visualise model summary

model.summary()
```

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_3 (Conv2D)           (None, 60, 60, 512)       13312

 max_pooling2d_3 (MaxPoolin  (None, 30, 30, 512)       0
 g2D)

 conv2d_4 (Conv2D)           (None, 28, 28, 256)       1179904

 max_pooling2d_4 (MaxPoolin  (None, 14, 14, 256)       0
 g2D)

 conv2d_5 (Conv2D)           (None, 12, 12, 256)       590080

 max_pooling2d_5 (MaxPoolin  (None, 6, 6, 256)         0
 g2D)

 flatten_1 (Flatten)         (None, 9216)              0

 dense_5 (Dense)             (None, 512)               4719104

 dropout_2 (Dropout)         (None, 512)               0

 dense_6 (Dense)             (None, 1024)              525312

 dense_7 (Dense)             (None, 512)               524800

 dropout_3 (Dropout)         (None, 512)               0

 dense_8 (Dense)             (None, 256)               131328

 dense_9 (Dense)             (None, 3)                 771

=================================================================
Total params: 7684611 (29.31 MB)
Trainable params: 7684611 (29.31 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

In [ ]:
```
# Compile and train the model

model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accurac
history = model.fit(X_train, Y_train, epochs=20, batch_size=16, validation_data=
```

```
Epoch 1/20
14/14 [==============================] - 3s 48ms/step - loss: 1.2623 - accuracy:
0.3302 - val_loss: 1.1244 - val_accuracy: 0.2222
Epoch 2/20
14/14 [==============================] - 0s 24ms/step - loss: 1.0896 - accuracy:
0.4093 - val_loss: 1.1438 - val_accuracy: 0.3333
Epoch 3/20
14/14 [==============================] - 0s 24ms/step - loss: 1.0326 - accuracy:
0.4744 - val_loss: 0.7221 - val_accuracy: 0.4444
Epoch 4/20
14/14 [==============================] - 0s 24ms/step - loss: 0.8274 - accuracy:
0.5721 - val_loss: 2.0637 - val_accuracy: 0.3333
Epoch 5/20
14/14 [==============================] - 0s 24ms/step - loss: 0.6953 - accuracy:
0.6465 - val_loss: 0.4982 - val_accuracy: 0.7778
Epoch 6/20
14/14 [==============================] - 0s 23ms/step - loss: 0.6981 - accuracy:
0.6512 - val_loss: 0.3593 - val_accuracy: 0.8889
Epoch 7/20
14/14 [==============================] - 0s 24ms/step - loss: 0.4079 - accuracy:
0.8837 - val_loss: 0.3331 - val_accuracy: 0.8889
Epoch 8/20
14/14 [==============================] - 0s 24ms/step - loss: 0.1896 - accuracy:
0.9488 - val_loss: 0.5692 - val_accuracy: 0.8889
Epoch 9/20
14/14 [==============================] - 0s 24ms/step - loss: 0.1188 - accuracy:
0.9581 - val_loss: 0.6346 - val_accuracy: 0.7778
Epoch 10/20
14/14 [==============================] - 0s 24ms/step - loss: 0.1142 - accuracy:
0.9535 - val_loss: 0.7112 - val_accuracy: 0.8889
Epoch 11/20
14/14 [==============================] - 0s 24ms/step - loss: 0.1222 - accuracy:
0.9674 - val_loss: 0.2369 - val_accuracy: 0.7778
Epoch 12/20
14/14 [==============================] - 0s 24ms/step - loss: 0.1204 - accuracy:
0.9581 - val_loss: 2.5354 - val_accuracy: 0.5556
Epoch 13/20
14/14 [==============================] - 0s 24ms/step - loss: 0.1941 - accuracy:
0.9488 - val_loss: 0.6457 - val_accuracy: 0.8889
Epoch 14/20
14/14 [==============================] - 0s 24ms/step - loss: 0.1075 - accuracy:
0.9628 - val_loss: 0.2858 - val_accuracy: 0.8889
Epoch 15/20
14/14 [==============================] - 0s 24ms/step - loss: 0.0653 - accuracy:
0.9674 - val_loss: 0.2416 - val_accuracy: 0.8889
Epoch 16/20
14/14 [==============================] - 0s 24ms/step - loss: 0.1074 - accuracy:
0.9581 - val_loss: 0.8729 - val_accuracy: 0.8889
Epoch 17/20
14/14 [==============================] - 0s 24ms/step - loss: 0.0558 - accuracy:
0.9814 - val_loss: 0.6920 - val_accuracy: 0.7778
Epoch 18/20
14/14 [==============================] - 0s 24ms/step - loss: 0.0422 - accuracy:
0.9860 - val_loss: 0.6819 - val_accuracy: 0.7778
Epoch 19/20
14/14 [==============================] - 0s 24ms/step - loss: 0.0215 - accuracy:
0.9907 - val_loss: 0.9691 - val_accuracy: 0.7778
Epoch 20/20
14/14 [==============================] - 0s 24ms/step - loss: 0.1933 - accuracy:
0.9349 - val_loss: 0.9324 - val_accuracy: 0.7778
```

In [ ]:
```
# Train and validation accuracy

train_accuracy = history.history['accuracy']
validation_accuracy = history.history['val_accuracy']

train_loss = history.history['loss']
validation_loss = history.history['val_loss']
```

In [ ]:
```
# Plot the accuracy and loss

_, axes = plt.subplots(nrows = 1, ncols = 2, figsize=(10,5))

# Plot accuracy
axes[0].plot(train_accuracy)
axes[0].plot(validation_accuracy)
axes[0].legend(['Train', 'Validation'])
axes[0].set_title("Accuracy per epoch")

# Plot loss
axes[1].plot(train_loss)
axes[1].plot(validation_loss)
axes[1].legend(['Train', 'Validation'])
axes[1].set_title("Loss per epoch")

plt.plot()
```

Out[ ]: []

In [ ]:
```
# Get test predictions

Y_pred = model.predict(X_test)
```

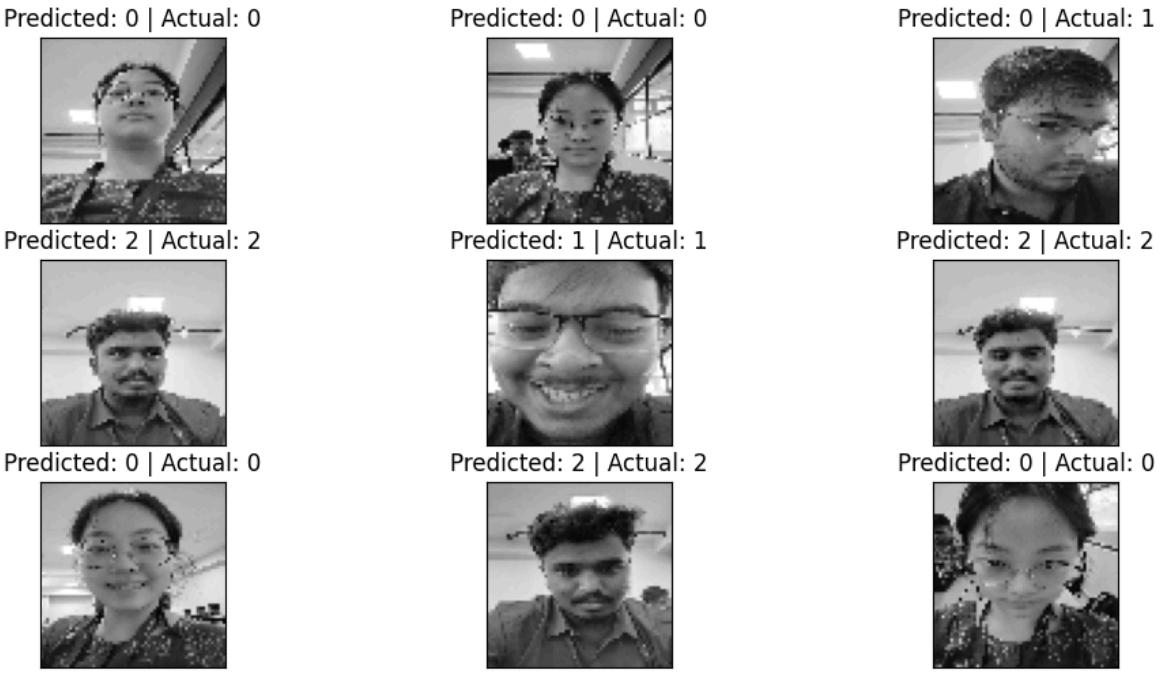
```
1/1 [==============================] - 0s 105ms/step
```

In [ ]:
```
# Find accuracy of the model

y_pred_classes = np.argmax(Y_pred, axis=1)
y_true = np.argmax(Y_test, axis=1)
```

```
accuracy = accuracy_score(y_true, y_pred_classes)
print(f'Test Accuracy: {accuracy:.4f}')
```

```
Test Accuracy: 0.9000
```

In [ ]:
```
_, axes = plt.subplots(nrows = 3, ncols = 3, figsize=(12,6))

for i, ax in enumerate(axes.flatten()):
    ax.imshow(X_test[i], cmap='gray')
    ax.set_xticks([])
    ax.set_yticks([])
    ax.set_title(f"Predicted: {decoder[y_pred_classes[i]]} | Actual: {decoder[y_
```



In [ ]:
```
model.save('face_recognition_model.h5')
```

```
/opt/conda/lib/python3.10/site-packages/keras/src/engine/training.py:3103: UserWa
rning: You are saving your model as an HDF5 file via `model.save()`. This file fo
rmat is considered legacy. We recommend using instead the native Keras format, e.
g. `model.save('my_model.keras')`.
  saving_api.save_model(
```

In [ ]:
```
import tensorflow as tf

# Assuming 'model' is your trained Keras model

# Convert the model to TFLite format
converter = tf.lite.TFLiteConverter.from_keras_model(model)
tflite_model = converter.convert()

# Save the TFLite model
with open('face_recognition_model.tflite', 'wb') as f:
    f.write(tflite_model)

print("Model saved as TFLite format")
```

```
Summary on the non-converted ops:
---------------------------------
 * Accepted dialects: tfl, builtin, func
 * Non-Converted Ops: 17, Total Ops 34, % non-converted = 50.00 %
 * 17 ARITH ops

- arith.constant:   17 occurrences  (f32: 16, i32: 1)



  (f32: 3)
  (f32: 5)
  (f32: 1)
  (f32: 3)
  (f32: 1)
  (f32: 1)
```

```
Model saved as TFLite format
```

In [ ]:

```python
import numpy as np
import cv2
import tensorflow as tf

# Load the TFLite model
interpreter = tf.lite.Interpreter(model_path="face_recognition_model.tflite")
interpreter.allocate_tensors()

# Get input and output tensors
input_details = interpreter.get_input_details()
output_details = interpreter.get_output_details()

# Define the decoder (same as in your training script)
decoder = [str(i) for i in range(10)] + [chr(i) for i in range(65, 91)] + [chr(i

# Function to preprocess the image
def preprocess_image(image_path):
    img = cv2.imread(image_path)
    gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    resized = cv2.resize(gray, (64, 64))
    normalized = resized.astype('float32') / 255.0
    return normalized, img

# Function to make prediction
def predict(image):
    input_data = np.expand_dims(image, axis=[0, -1])
    interpreter.set_tensor(input_details[0]['index'], input_data)
    interpreter.invoke()
    output_data = interpreter.get_tensor(output_details[0]['index'])
    return output_data

# Test on a sample image
image_path = "/kaggle/input/hahahhahahahhaha/img/IMG_20240805_131933222_HDR.jpg"
processed_image, original_image = preprocess_image(image_path)

# Make prediction
prediction = predict(processed_image)
predicted_class = decoder[np.argmax(prediction)]

print(f"Predicted class: {predicted_class}")

# Display result on the image
```

```
cv2.putText(original_image, f"Predicted: {predicted_class}", (10, 30), cv2.FONT_

# Save the resulting image
cv2.imwrite('/kaggle/working/result.jpg', original_image)
print("Result saved as 'result.jpg'")
```

```
Predicted class: 0
Result saved as 'result.jpg'
```

In [ ]: