```
import numpy as np
import os
import imageio
from skimage.transform import resize, rescale
import datetime
import os
import matplotlib.pyplot as plt


import tensorflow as tf
print(tf.__version__)
np.random.seed(30)
import random as rn
rn.seed(30)
from keras import backend as K
tf.random.set_seed(30)
```

```
     2.12.0
```

```
from google.colab import drive
drive.mount('/content/drive', force_remount=True)
```

```
     Mounted at /content/drive
```

```
# !unzip "$/mnt/Project_data.zip" -d "$/home/Project_data.zip"


train_doc = np.random.permutation(open('/content/drive/MyDrive/Project_data/train.csv').readlines())
val_doc = np.random.permutation(open('/content/drive/MyDrive/Project_data/val.csv').readlines())
batch_size = 8 #experiment with the batch size
num_classes = 5  #number of softmax classes


curr_dt_time = datetime.datetime.now()
train_path = '/content/drive/MyDrive/Project_data/train/'
val_path = '/content/drive/MyDrive/Project_data/val/'
num_train_sequences = len(train_doc)
print('# training sequences =', num_train_sequences)
num_val_sequences = len(val_doc)
print('# validation sequences =', num_val_sequences)
```

```
     # training sequences = 663
     # validation sequences = 100
```

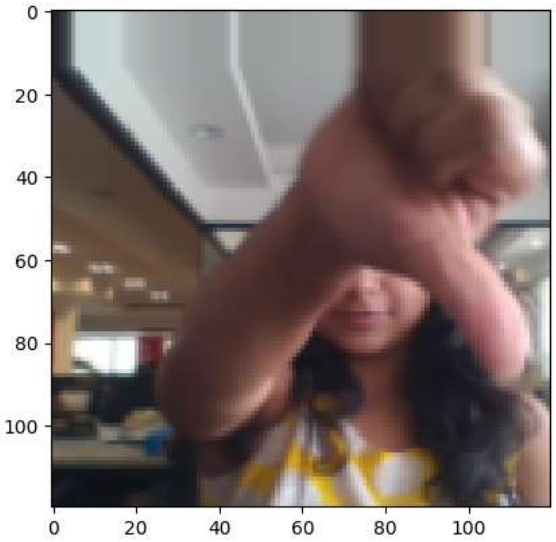
```
total_frames = 30
num_frames = 15
gestures = 5
image_height = 100
image_width = 100
img_idx = np.round(np.linspace(0, total_frames-1, num_frames)).astype(int) #create a list of image numbers you want to use for a parti


def plot_loss_accuracy(history):
    # list all data in history
    print(history.history.keys())
    # summarize history for accuracy
    plt.plot(history.history['categorical_accuracy'])
    plt.plot(history.history['val_categorical_accuracy'])
    plt.title('model accuracy')
    plt.ylabel('accuracy')
    plt.xlabel('epoch')
    plt.legend(['train', 'test'], loc='upper left')
    plt.show()
    # summarize history for loss
    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()
```

```
def calculate_steps(num_train_sequences, num_val_sequences, batch_size):
    if (num_train_sequences%batch_size) == 0:
        steps_per_epoch = int(num_train_sequences/batch_size)
    else:
        steps_per_epoch = (num_train_sequences//batch_size) + 1

    if (num_val_sequences%batch_size) == 0:
        validation_steps = int(num_val_sequences/batch_size)
    else:
        validation_steps = (num_val_sequences//batch_size) + 1

    return steps_per_epoch,validation_steps


def model_callbacks(folder_name):
    model_name = str(folder_name) + '_' + str(curr_dt_time).replace(' ','').replace(':','_') + '/'

    if not os.path.exists(model_name):
        os.mkdir(model_name)

    filepath = model_name + 'model-{epoch:05d}-{loss:.5f}-{categorical_accuracy:.5f}-{val_loss:.5f}-{val_categorical_accuracy:.5f}.h5'

    checkpoint = ModelCheckpoint(filepath, monitor='val_loss', verbose=1, save_best_only=True, save_weights_only=False, mode='auto', p

    LR = ReduceLROnPlateau(monitor='val_loss', factor=0.1, patience=3, min_lr=0.0001, cooldown=1, verbose=1) # write the REducelronpla

    return [checkpoint, LR]
```

This is one of the most important part of the code. The overall structure of the generator has been given. In the generator, you are going to preprocess the images as you have images of 2 different dimensions as well as create a batch of video frames. You have to experiment with img_idx, y,z and normalization such that you get high accuracy.

```
from keras.preprocessing.image import ImageDataGenerator
#from keras.preprocessing.image import smart_resize

datagen = ImageDataGenerator(
    zoom_range=0.1,
    zca_whitening=True,
    width_shift_range=0.1,
    height_shift_range=0.1)

image1 = imageio.imread("/content/drive/MyDrive/Project_data/val/WIN_20180907_15_42_25_Pro_Thumbs Down_new/WIN_20180907_15_42_25_Pro_0
image2 = imageio.imread("/content/drive/MyDrive/Project_data/val/WIN_20180907_15_42_25_Pro_Thumbs Down_new/WIN_20180907_15_42_25_Pro_0
image1 = resize(image1, (120, 120), anti_aliasing=True)
image1 = datagen.random_transform(image1)
plt.imshow(image1)
plt.show()
image2 = resize(image2, (120, 120), anti_aliasing=True)
image2 = datagen.random_transform(image2)
plt.imshow(image2)
plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/keras/preprocessing/image.py:1444: UserWarning: This ImageDataGenerator specifies `zca_whi
  warnings.warn(
<ipython-input-86-1d30d9113362>:10: DeprecationWarning: Starting with ImageIO v3 the behavior of this function will switch to that
  image1 = imageio.imread("/content/drive/MyDrive/Project_data/val/WIN_20180907_15_42_25_Pro_Thumbs Down_new/WIN_20180907_15_42_25
<ipython-input-86-1d30d9113362>:11: DeprecationWarning: Starting with ImageIO v3 the behavior of this function will switch to that
  image2 = imageio.imread("/content/drive/MyDrive/Project_data/val/WIN_20180907_15_42_25_Pro_Thumbs Down_new/WIN_20180907_15_42_25
```




```
def resize_crop_image(image):
    if image.shape[0] > 120 and image.shape[1] > 120:
        image = resize(image, (120, 120))

    height = image.shape[0]
    width = image.shape[1]
    height_center = height//2
    width_center = width//2
    image = image[(height_center-60):(height_center+70), (width_center-50):(width_center+70)]
    image = resize(image,(image_height, image_width))
    return image

from matplotlib import pyplot as plt

def show_resize_crop_image(paths):

    for index, path in enumerate(paths):
        plt.figure(figsize=(20,20))

        plt.subplot(5, 2, index*2+1)
        image = resize_crop_image(imread(path))
        plt.imshow(image)
        plt.title('Modified')

        plt.subplot(5, 2, index*2+2)
        plt.imshow(imread(path))
        plt.title('Original')

    plt.show()
```

Function to rescale and resize the original Image

```
import numpy as np
import os
from imageio import imread
from skimage.transform import resize
import datetime
import os
```

```
def generator(source_path, folder_list, batch_size):
    print('Source path = ', source_path, '; batch size =', batch_size)
    while True:
        t = np.random.permutation(folder_list)
        num_batches = len(folder_list) // batch_size
        for batch in range(num_batches):
            batch_data = np.zeros((batch_size, len(img_idx), image_height, image_width, 3))
            batch_labels = np.zeros((batch_size, gestures))

            for folder in range(batch_size):
                imgs = os.listdir(os.path.join(source_path, t[folder + (batch * batch_size)].split(';')[0]))
                print(imgs)

                for idx, item in enumerate(img_idx):
                    img_path = os.path.join(source_path, t[folder + (batch * batch_size)].strip().split(';')[0], imgs[item])
                    image = imread(img_path).astype(np.float32)
                    image = resize_crop_image(image)

                    batch_data[folder, idx, :, :, 0] = image[:, :, 0]
                    batch_data[folder, idx, :, :, 1] = image[:, :, 1]
                    batch_data[folder, idx, :, :, 2] = image[:, :, 2]

                batch_labels[folder, int(t[folder + (batch * batch_size)].strip().split(';')[2])] = 1

            yield batch_data, batch_labels

        # Handling remaining data points
        if len(folder_list) % batch_size != 0:
            batch_size_remainder = len(folder_list) % batch_size

            for batch in range(batch_size_remainder):
                batch_data = np.zeros((batch_size_remainder, len(img_idx), image_height, image_width, 3))
                batch_labels = np.zeros((batch_size_remainder, gestures))

                for folder in range(batch_size_remainder):
                    imgs = os.listdir(os.path.join(source_path, t[folder + (num_batches * batch_size)].split(';')[0]))

                    for idx, item in enumerate(img_idx):
                        img_path = os.path.join(source_path, t[folder + (num_batches * batch_size)].strip().split(';')[0], imgs[item])
                        image = imread(img_path).astype(np.float32)
                        image = resize_crop_image(image)

                        batch_data[folder, idx, :, :, 0] = image[:, :, 0]
                        batch_data[folder, idx, :, :, 1] = image[:, :, 1]
                        batch_data[folder, idx, :, :, 2] = image[:, :, 2]

                    batch_labels[folder, int(t[folder + (num_batches * batch_size)].strip().split(';')[2])] = 1

                yield batch_data, batch_labels
```

Import libraries

```
from keras.models import Sequential, Model
from keras.layers import Dense, Dropout, GRU, LSTM, Flatten, TimeDistributed, Flatten, BatchNormalization, Activation
from keras.layers.convolutional import Conv3D, MaxPooling3D, Conv2D, MaxPooling2D
from keras.callbacks import ModelCheckpoint, ReduceLROnPlateau
from keras.regularizers import l2
from keras import optimizers
```

Build Model: Experiment 1

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, GRU, Dropout, Flatten, BatchNormalization, Activation, Conv3D, MaxPooling3D
from tensorflow.keras.callbacks import ModelCheckpoint, ReduceLROnPlateau
from tensorflow.keras import optimizers

#write your model here
model = Sequential()

model.add(Conv3D(8, kernel_size=(3,3,3), input_shape=(len(img_idx), image_height, image_width, 3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling3D(pool_size=(2,2,2)))

model.add(Conv3D(16, kernel_size=(3,3,3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling3D(pool_size=(2,2,2)))

model.add(Conv3D(32, kernel_size=(3,3,3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling3D(pool_size=(2,2,2)))

model.add(Flatten())

model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))

model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))

#softmax layer
model.add(Dense(gestures, activation='softmax'))


# compile it
model.compile(loss='categorical_crossentropy', optimizer='sgd', metrics=['categorical_accuracy'])

# summary of model
model.summary()
```

```
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv3d_6 (Conv3D)           (None, 15, 100, 100, 8)   656

 batch_normalization_6 (Batc  (None, 15, 100, 100, 8)  32
 hNormalization)

 activation_6 (Activation)   (None, 15, 100, 100, 8)   0

 max_pooling3d_6 (MaxPooling  (None, 7, 50, 50, 8)     0
 3D)

 conv3d_7 (Conv3D)           (None, 7, 50, 50, 16)     3472

 batch_normalization_7 (Batc  (None, 7, 50, 50, 16)    64
 hNormalization)

 activation_7 (Activation)   (None, 7, 50, 50, 16)     0

 max_pooling3d_7 (MaxPooling  (None, 3, 25, 25, 16)    0
 3D)

 conv3d_8 (Conv3D)           (None, 3, 25, 25, 32)     13856

 batch_normalization_8 (Batc  (None, 3, 25, 25, 32)    128
 hNormalization)

 activation_8 (Activation)   (None, 3, 25, 25, 32)     0

 max_pooling3d_8 (MaxPooling  (None, 1, 12, 12, 32)    0
 3D)

 flatten_2 (Flatten)         (None, 4608)              0

 dense_6 (Dense)             (None, 64)                294976

 dropout_4 (Dropout)         (None, 64)                0

 dense_7 (Dense)             (None, 64)                4160

 dropout_5 (Dropout)         (None, 64)                0

 dense_8 (Dense)             (None, 5)                 325
```

```
=================================================================
Total params: 317,669
Trainable params: 317,557
Non-trainable params: 112
_________________________________________________________________
```

```
train_generator = generator(train_path, train_doc, batch_size)
val_generator = generator(val_path, val_doc, batch_size)


model_name = 'model_init_' + str(curr_dt_time).replace(' ','').replace(':','_') + '/'

if not os.path.exists(model_name):
    os.mkdir(model_name)

filepath = model_name + 'model-{epoch:05d}-{loss:.5f}-{categorical_accuracy:.5f}-{val_loss:.5f}-{val_categorical_accuracy:.5f}.h5'

checkpoint = ModelCheckpoint(filepath, monitor='val_loss', verbose=1, save_best_only=True, save_weights_only=False, mode='auto',save_f

LR = ReduceLROnPlateau(monitor='val_loss', factor=0.5, patience=2, cooldown=1, verbose=1) # write the REducelronplateau code here
callbacks_list = [checkpoint, LR]


if (num_train_sequences%batch_size) == 0:
    steps_per_epoch = int(num_train_sequences/batch_size)
else:
    steps_per_epoch = (num_train_sequences//batch_size) + 1

if (num_val_sequences%batch_size) == 0:
    validation_steps = int(num_val_sequences/batch_size)
else:
    validation_steps = (num_val_sequences//batch_size) + 1


history = model.fit(train_generator, steps_per_epoch=steps_per_epoch, epochs=5, verbose=1,
                    callbacks=callbacks_list, validation_data=val_generator,
                    validation_steps=validation_steps, class_weight=None, workers=1, initial_epoch=0)
```

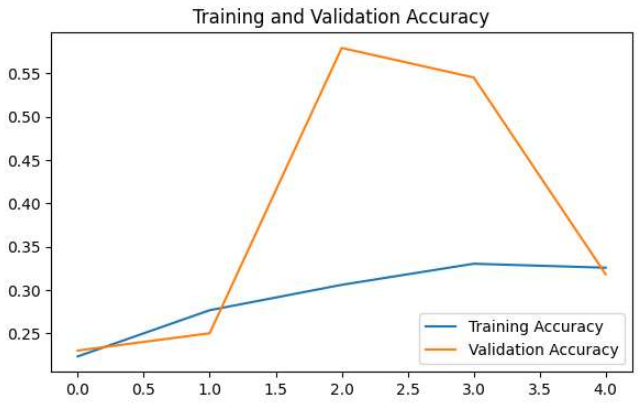
```
9.png', 'WIN_20180925_18_20_19_Pro_00021.png', 'WIN_20180925_18_20_19_Pro_00049.png', 'WIN_20180925_18_20_19_Pro_00027.png', 'WI
16_37_46_Pro_00009.png', 'WIN_20180926_16_37_46_Pro_00039.png', 'WIN_20180926_16_37_46_Pro_00029.png', 'WIN_20180926_16_37_46_Pr
0.png', 'WIN_20180907_16_13_12_Pro_00048.png', 'WIN_20180907_16_13_12_Pro_00022.png', 'WIN_20180907_16_13_12_Pro_00050.png', 'WI
8.png', 'WIN_20180925_17_57_36_Pro_00031.png', 'WIN_20180925_17_57_36_Pro_00035.png', 'WIN_20180925_17_57_36_Pro_00029.png', 'WI
6.png', 'WIN_20180926_17_02_27_Pro_00046.png', 'WIN_20180926_17_02_27_Pro_00024.png', 'WIN_20180926_17_02_27_Pro_00034.png', 'WI
2.png', 'WIN_20180925_17_42_57_Pro_00015.png', 'WIN_20180925_17_42_57_Pro_00013.png', 'WIN_20180925_17_42_57_Pro_00024.png', 'WI
0.png', 'WIN_20180925_17_22_11_Pro_00019.png', 'WIN_20180925_17_22_11_Pro_00025.png', 'WIN_20180925_17_22_11_Pro_00021.png', 'WI
1.png', 'WIN_20180907_16_22_23_Pro_00025.png', 'WIN_20180907_16_22_23_Pro_00043.png', 'WIN_20180907_16_22_23_Pro_00027.png', 'WI
6.png', 'WIN_20180926_17_40_52_Pro_00028.png', 'WIN_20180926_17_40_52_Pro_00002.png', 'WIN_20180926_17_40_52_Pro_00018.png', 'WI
6 59 55 Pro 00055.png', 'WIN 20180926 16 59 55 Pro 00021.png', 'WIN 20180926 16 59 55 Pro 00013.png', 'WIN 20180926 16 59 55 Pro
```

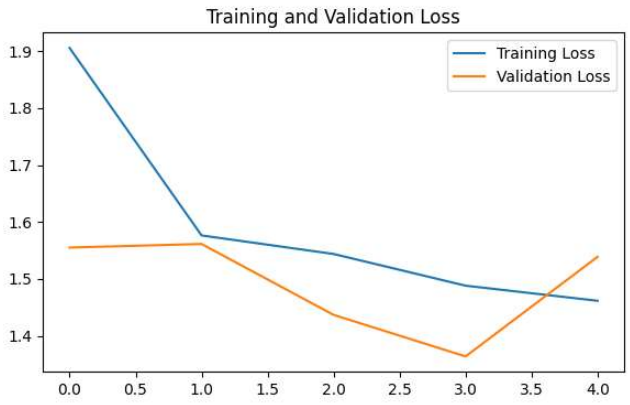
Plot results

```
from IPython.display import Markdown, display
num_epochs = 5
def plot_history(history):
    display(Markdown("**Training Accuracy:** " + str(round(history.history['categorical_accuracy'][num_epochs-1], 2)) + "%"))
    display(Markdown("**Validation Accuracy:** " + str(round(history.history['val_categorical_accuracy'][num_epochs-1], 2)) + "%"))

    #print("Training Accuracy:" + history.history['categorical_accuracy'][num_epochs-1])
    #print("Validation Accuracy:" + history.history['val_categorical_accuracy'][num_epochs-1])

    acc = history.history['categorical_accuracy']
    val_acc = history.history['val_categorical_accuracy']

    loss = history.history['loss']
    val_loss = history.history['val_loss']

    epochs_range = range(num_epochs)

    plt.figure(figsize=(15, 4))
    plt.subplot(1, 2, 1)
    plt.plot(epochs_range, acc, label='Training Accuracy')
    plt.plot(epochs_range, val_acc, label='Validation Accuracy')
    plt.legend(loc='lower right')
    plt.title('Training and Validation Accuracy')

    plt.subplot(1, 2, 2)
    plt.plot(epochs_range, loss, label='Training Loss')
    plt.plot(epochs_range, val_loss, label='Validation Loss')
    plt.legend(loc='upper right')
    plt.title('Training and Validation Loss')
    plt.show()

plot_history(history)
```

Training Accuracy: 0.33%

Validation Accuracy: 0.32%





Experiment 2:

```
total_frames = 30
num_frames = 15
gestures = 5
image_height = 50
image_width = 50
img_idx = np.round(np.linspace(0, total_frames-1, num_frames)).astype(int)

num_epochs=10
```

```
#write your model here
model = Sequential()

model.add(Conv3D(8, kernel_size=(3,3,3), input_shape=(len(img_idx), image_height, image_width, 3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling3D(pool_size=(2,2,2)))

model.add(Conv3D(16, kernel_size=(3,3,3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling3D(pool_size=(2,2,2)))

model.add(Conv3D(32, kernel_size=(3,3,3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling3D(pool_size=(2,2,2)))

model.add(Flatten())

model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))

model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))

#softmax layer
model.add(Dense(gestures, activation='softmax'))


# compile it
model.compile(loss='categorical_crossentropy', optimizer='sgd', metrics=['categorical_accuracy'])
# summary of model
model.summary()
```

```
Model: "sequential_3"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv3d_9 (Conv3D)           (None, 15, 50, 50, 8)     656

 batch_normalization_9 (Batc  (None, 15, 50, 50, 8)    32
 hNormalization)

 activation_9 (Activation)   (None, 15, 50, 50, 8)     0

 max_pooling3d_9 (MaxPooling  (None, 7, 25, 25, 8)     0
 3D)

 conv3d_10 (Conv3D)          (None, 7, 25, 25, 16)     3472

 batch_normalization_10 (Bat  (None, 7, 25, 25, 16)    64
 chNormalization)

 activation_10 (Activation)  (None, 7, 25, 25, 16)     0

 max_pooling3d_10 (MaxPoolin  (None, 3, 12, 12, 16)    0
 g3D)

 conv3d_11 (Conv3D)          (None, 3, 12, 12, 32)     13856

 batch_normalization_11 (Bat  (None, 3, 12, 12, 32)    128
 chNormalization)

 activation_11 (Activation)  (None, 3, 12, 12, 32)     0

 max_pooling3d_11 (MaxPoolin  (None, 1, 6, 6, 32)      0
 g3D)

 flatten_3 (Flatten)         (None, 1152)              0

 dense_9 (Dense)             (None, 64)                73792

 dropout_6 (Dropout)         (None, 64)                0

 dense_10 (Dense)            (None, 64)                4160

 dropout_7 (Dropout)         (None, 64)                0

 dense_11 (Dense)            (None, 5)                 325

=================================================================
Total params: 96,485
Trainable params: 96,373
Non-trainable params: 112
_________________________________________________________________
```

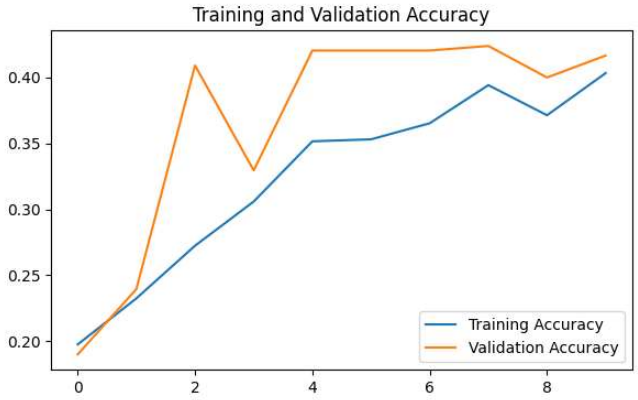
```
train_generator = generator(train_path, train_doc, batch_size)
val_generator = generator(val_path, val_doc, batch_size)


model_name = 'exp2' + str(curr_dt_time).replace(' ','').replace(':','_') + '/'

if not os.path.exists(model_name):
    os.mkdir(model_name)

filepath = model_name + 'model-{epoch:05d}-{loss:.5f}-{categorical_accuracy:.5f}-{val_loss:.5f}-{val_categorical_accuracy:.5f}.h5'

checkpoint = ModelCheckpoint(filepath, monitor='val_loss', verbose=1, save_best_only=True, save_weights_only=False, mode='auto',save_f

LR = ReduceLROnPlateau(monitor='val_loss', factor=0.5, patience=2, cooldown=1, verbose=1) # write the REducelronplateau code here
callbacks_list = [checkpoint, LR]


if (num_train_sequences%batch_size) == 0:
    steps_per_epoch = int(num_train_sequences/batch_size)
else:
    steps_per_epoch = (num_train_sequences//batch_size) + 1

if (num_val_sequences%batch_size) == 0:
    validation_steps = int(num_val_sequences/batch_size)
else:
    validation_steps = (num_val_sequences//batch_size) + 1


history = model.fit(train_generator, steps_per_epoch=steps_per_epoch, epochs=num_epochs, verbose=1,
                    callbacks=callbacks_list, validation_data=val_generator,
                    validation_steps=validation_steps, class_weight=None, workers=1, initial_epoch=0)
```

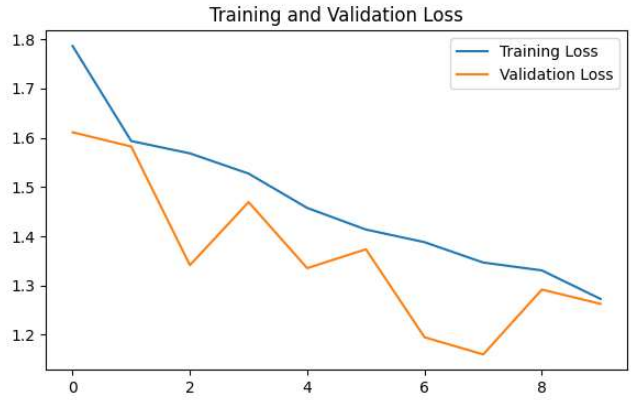
```
['WIN_20180926_17_32_15_Pro_00015.png', 'WIN_20180926_17_32_15_Pro_00005.png', 'WIN_20180926_17_32_15_Pro_00025.png', 'WIN_2018
['WIN_20180926_17_32_55_Pro_00017.png', 'WIN_20180926_17_32_55_Pro_00030.png', 'WIN_20180926_17_32_55_Pro_00026.png', 'WIN_2018
['WIN_20180907_15_45_40_Pro_00015.png', 'WIN_20180907_15_45_40_Pro_00013.png', 'WIN_20180907_15_45_40_Pro_00017.png', 'WIN_2018
```

```
plot_history(history)
```

Training Accuracy: 0.4%

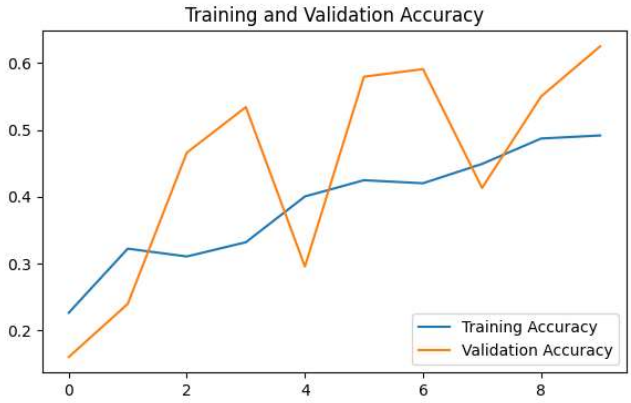
Validation Accuracy: 0.42%





Training Accuracy: 0.49%

Validation Accuracy: 0.62%



Experiment 2

```
# Change the number of epochs

total_frames = 30
num_frames = 15
gestures = 5
image_height = 50
image_width = 50
img_idx = np.round(np.linspace(0, total_frames-1, num_frames)).astype(int)

num_epochs=10
```

Build a model

```
model = Sequential()

model.add(Conv3D(8, kernel_size=(3,3,3), input_shape=(len(img_idx), image_height, image_width, 3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling3D(pool_size=(2,2,2)))

model.add(Conv3D(16, kernel_size=(3,3,3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling3D(pool_size=(2,2,2)))

model.add(Conv3D(32, kernel_size=(3,3,3), padding='same'))
model.add(BatchNormalization())
model.add(Activation('relu'))
model.add(MaxPooling3D(pool_size=(2,2,2)))

model.add(Flatten())

model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))

model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))

#softmax layer
model.add(Dense(gestures, activation='softmax'))


# compile it
model.compile(loss='categorical_crossentropy', optimizer='sgd', metrics=['categorical_accuracy'])
# summary of model
model.summary()
```

```
Model: "sequential_4"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv3d_12 (Conv3D)          (None, 15, 50, 50, 8)     656

 batch_normalization_12 (Bat  (None, 15, 50, 50, 8)    32
 chNormalization)

 activation_12 (Activation)  (None, 15, 50, 50, 8)     0

 max_pooling3d_12 (MaxPoolin  (None, 7, 25, 25, 8)     0
 g3D)

 conv3d_13 (Conv3D)          (None, 7, 25, 25, 16)     3472

 batch_normalization_13 (Bat  (None, 7, 25, 25, 16)    64
 chNormalization)

 activation_13 (Activation)  (None, 7, 25, 25, 16)     0

 max_pooling3d_13 (MaxPoolin  (None, 3, 12, 12, 16)    0
 g3D)

 conv3d_14 (Conv3D)          (None, 3, 12, 12, 32)     13856

 batch_normalization_14 (Bat  (None, 3, 12, 12, 32)    128
 chNormalization)

 activation_14 (Activation)  (None, 3, 12, 12, 32)     0

 max_pooling3d_14 (MaxPoolin  (None, 1, 6, 6, 32)      0
 g3D)

 flatten_4 (Flatten)         (None, 1152)              0

 dense_12 (Dense)            (None, 64)                73792

 dropout_8 (Dropout)         (None, 64)                0

 dense_13 (Dense)            (None, 64)                4160

 dropout_9 (Dropout)         (None, 64)                0

 dense_14 (Dense)            (None, 5)                 325

=================================================================
Total params: 96,485
Trainable params: 96,373
Non-trainable params: 112
_________________________________________________________________
```

```
train_generator = generator(train_path, train_doc, batch_size)
val_generator = generator(val_path, val_doc, batch_size)


model_name = 'exp3' + str(curr_dt_time).replace(' ','').replace(':','_') + '/'

if not os.path.exists(model_name):
    os.mkdir(model_name)

filepath = model_name + 'model-{epoch:05d}-{loss:.5f}-{categorical_accuracy:.5f}-{val_loss:.5f}-{val_categorical_accuracy:.5f}.h5'

checkpoint = ModelCheckpoint(filepath, monitor='val_loss', verbose=1, save_best_only=True, save_weights_only=False, mode='auto',save_f

LR = ReduceLROnPlateau(monitor='val_loss', factor=0.5, patience=2, cooldown=1, verbose=1) # write the REducelronplateau code here
callbacks_list = [checkpoint, LR]


history = model.fit(train_generator, steps_per_epoch=steps_per_epoch, epochs=num_epochs, verbose=1,
                    callbacks=callbacks_list, validation_data=val_generator,
                    validation_steps=validation_steps, class_weight=None, workers=1, initial_epoch=0)
```

```
Source path =  /content/drive/MyDrive/Project_data/train/ ; batch size = 8
['WIN_20180925_17_41_24_Pro_00015.png', 'WIN_20180925_17_41_24_Pro_00028.png', 'WIN_20180925_17_41_24_Pro_00036.png', 'WIN_2018(
['WIN_20180926_17_27_40_Pro_00021.png', 'WIN_20180926_17_27_40_Pro_00016.png', 'WIN_20180926_17_27_40_Pro_00014.png', 'WIN_2018(
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<ipython-input-56-6974d9b60e77>:16: DeprecationWarning: Starting with ImageIO v3 the behavior of this function will switch to th
  image = imread(img_path).astype(np.float32)
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Epoch 1/10
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 1/83 [..............................] - ETA: 4:52 - loss: 2.9221 - categorical_accuracy: 0.2500['WIN_20180926_16_39_45_Pro_0001
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 2/83 [..............................] - ETA: 2:33 - loss: 2.6055 - categorical_accuracy: 0.1875['WIN_20180925_18_07_19_Pro_0001
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 3/83 [>.............................] - ETA: 2:38 - loss: 2.5790 - categorical_accuracy: 0.2083['WIN_20180926_17_24_54_Pro_0002
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 5/83 [>.............................] - ETA: 2:28 - loss: 2.6225 - categorical_accuracy: 0.1500['WIN_20180925_17_39_48_Pro_0003
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```