In [ ]:

```
#!pip install wandb
#import wandb
#wandb.init()
```

In [ ]:

```
import os
import cv2
import math
import random
import numpy as np
import datetime as dt
import tensorflow as tf
from tensorflow import keras


import matplotlib.pyplot as plt
%matplotlib inline

from sklearn.model_selection import train_test_split

from tensorflow.keras.layers import *
from tensorflow.keras.models import Sequential
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.utils import plot_model

from keras.applications.vgg16 import VGG16
from keras.applications.vgg16 import preprocess_input
```

In [ ]:

```
from google.colab import drive
drive.mount('/gdrive')
%cd /gdrive
```

```
Drive already mounted at /gdrive; to attempt to forcibly remount, call drive.mount
("/gdrive", force_remount=True).
/gdrive
```

In [ ]:

```
%cd 'My Drive'

%cd 'Action Recognition'
```

```
/gdrive/My Drive
/gdrive/My Drive/Action Recognition
```

In [ ]:

```
image_height, image_width = 64, 64
images_per_class = 8000
dataset_directory = "hmdb51"
classes_list = ["pullup", "punch", "dive", "fencing", "ride_bike", "golf"]
model_output_size = len(classes_list)
```

In [ ]:

```
def frames_extraction(video_path):
    frames_list = []
    video_reader = cv2.VideoCapture(video_path)
```

In ...

```
def create_dataset():


    temp_features = []
    features = []
    labels = []


    for class_index, class_name in enumerate(classes_list):
        print(f'Extracting Data of Class: {class_name}')


        files_list = os.listdir(os.path.join(dataset_directory, class_name))


        for file_name in files_list:
            video_file_path = os.path.join(dataset_directory, class_name, file_n
            frames = frames_extraction(video_file_path)
            temp_features.extend(frames)
        features.extend(random.sample(temp_features, images_per_class))
        labels.extend([class_index] * images_per_class)
        temp_features.clear()

    features = np.asarray(features)
    labels = np.array(labels)

    return features, labels
```

In [ ]:

```
features, labels = create_dataset()
```

```
Extracting Data of Class: pullup
Defected frame
Defected frame
Defected frame
Defected frame
Defected frame
Defected frame
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Defected frame
```

In [ ]:

```
seed_constant = 23
np.random.seed(seed_constant)
random.seed(seed_constant)
tf.random.set_seed(seed_constant)
```

I...

```
print (features.shape)
print (labels.shape)

one_hot_encoded_labels = to_categorical(labels)

features_train, features_test, labels_train, labels_test = train_test_split(featur

print (features_train.shape)
print (labels_train.shape)
```

```
(48000, 64, 64, 3)
(48000,)
(38400, 64, 64, 3)
(38400, 6)
```

In [ ]:

```
print (labels_train)
```

```
[[0. 0. 1. 0. 0. 0.]
 [1. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 1. 0.]
 ...
 [0. 0. 0. 1. 0. 0.]
 [0. 1. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 1.]]
```

In...

```
# Load model
base_model = Sequential()
base_model.add(VGG16(input_shape=(64,64,3), weights='imagenet', include_top=Fals
base_model.add(Dense(288, activation = 'relu'))
base_model.add(Dense(288, activation = 'relu'))
base_model.add(Dense(6, activation='softmax'))
# summarize the model

base_model.layers[0].trainable = False
```

In ...

```
base_model.compile(optimizer='sgd',loss='categorical_crossentropy',metrics=['acc
```

In [ ]:

```
plot_model(base_model,show_shapes = True, show_layer_names = True)
```

Out[ ]:

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```
# Adding Early Stopping Callback
early_stopping_callback = EarlyStopping(monitor = 'val_loss', patience = 10, mode

# Start Training
model_training_history = base_model.fit(x = features_train, y = labels_train, epoc
Epoch 1/40
1920/1920 [==============================] - 35s 10ms/step - loss: 0.1594 - accurac
y: 0.9585 - val_loss: 0.0309 - val_accuracy: 0.9908
Epoch 2/40
1920/1920 [==============================] - 18s 9ms/step - loss: 0.0101 - accuracy:
0.9976 - val_loss: 0.0147 - val_accuracy: 0.9960
Epoch 3/40
1920/1920 [==============================] - 18s 10ms/step - loss: 0.0030 - accurac
y: 0.9998 - val_loss: 0.0113 - val_accuracy: 0.9966
Epoch 4/40
1920/1920 [==============================] - 18s 10ms/step - loss: 0.0015 - accurac
y: 1.0000 - val_loss: 0.0096 - val_accuracy: 0.9975
Epoch 5/40
1920/1920 [==============================] - 18s 10ms/step - loss: 9.9968e-04 - accu
racy: 1.0000 - val_loss: 0.0088 - val_accuracy: 0.9975
Epoch 6/40
1920/1920 [==============================] - 18s 9ms/step - loss: 7.3064e-04 - accur
acy: 1.0000 - val_loss: 0.0080 - val_accuracy: 0.9979
Epoch 7/40
1920/1920 [==============================] - 18s 9ms/step - loss: 5.8856e-04 - accur
acy: 1.0000 - val_loss: 0.0077 - val_accuracy: 0.9978
Epoch 8/40
1920/1920 [==============================] - 18s 10ms/step - loss: 4.8512e-04 - accu
racy: 1.0000 - val_loss: 0.0077 - val_accuracy: 0.9978
Epoch 9/40
1920/1920 [==============================] - 18s 9ms/step - loss: 4.1695e-04 - accur
acy: 1.0000 - val_loss: 0.0075 - val_accuracy: 0.9977
Epoch 10/40
1920/1920 [==============================] - 18s 9ms/step - loss: 3.6671e-04 - accur
acy: 1.0000 - val_loss: 0.0071 - val_accuracy: 0.9978
Epoch 11/40
1920/1920 [==============================] - 18s 9ms/step - loss: 3.2759e-04 - accur
acy: 1.0000 - val_loss: 0.0070 - val_accuracy: 0.9979
Epoch 12/40
1920/1920 [==============================] - 18s 9ms/step - loss: 2.9161e-04 - accur
acy: 1.0000 - val_loss: 0.0071 - val_accuracy: 0.9978
Epoch 13/40
1920/1920 [==============================] - 18s 9ms/step - loss: 2.6644e-04 - accur
acy: 1.0000 - val_loss: 0.0070 - val_accuracy: 0.9980
Epoch 14/40
1920/1920 [==============================] - 18s 10ms/step - loss: 2.4417e-04 - accu
racy: 1.0000 - val_loss: 0.0068 - val_accuracy: 0.9979
Epoch 15/40
1920/1920 [==============================] - 18s 9ms/step - loss: 2.2375e-04 - accur
acy: 1.0000 - val_loss: 0.0069 - val_accuracy: 0.9980
Epoch 16/40
1920/1920 [==============================] - 18s 9ms/step - loss: 2.0753e-04 - accur
acy: 1.0000 - val_loss: 0.0067 - val_accuracy: 0.9979
Epoch 17/40
1920/1920 [==============================] - 18s 9ms/step - loss: 1.9307e-04 - accur
acy: 1.0000 - val_loss: 0.0068 - val_accuracy: 0.9980
Epoch 18/40
1920/1920 [==============================] - 18s 10ms/step - loss: 1.8017e-04 - accu
racy: 1.0000 - val_loss: 0.0067 - val_accuracy: 0.9979
Epoch 19/40
1920/1920 [==============================] - 18s 9ms/step - loss: 1.6935e-04 - accur
acy: 1.0000 - val_loss: 0.0066 - val_accuracy: 0.9980
Epoch 20/40
1920/1920 [==============================] - 18s 9ms/step - loss: 1.5937e-04 - accur
```

In [ ]:

```
model_evaluation_history = base_model.evaluate(features_test, labels_test)

from sklearn.metrics import classification_report

y_pred = base_model.predict(features_test, batch_size=4, verbose=1)
y_pred_bool = np.argmax(y_pred, axis=1)

l_test=np.argmax(labels_test, axis=1)

print(classification_report(l_test, y_pred_bool))
```

```
300/300 [==============================] - 4s 11ms/step - loss: 0.0114 - accuracy:
0.9972
2400/2400 [==============================] - 9s 4ms/step
              precision    recall  f1-score   support

           0       1.00      1.00      1.00      1604
           1       1.00      1.00      1.00      1615
           2       1.00      0.99      1.00      1593
           3       0.99      1.00      0.99      1585
           4       1.00      1.00      1.00      1602
           5       1.00      1.00      1.00      1601

    accuracy                           1.00      9600
   macro avg       1.00      1.00      1.00      9600
weighted avg       1.00      1.00      1.00      9600
```

In [ ]:

```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(l_test, y_pred_bool)

print (cm)
```

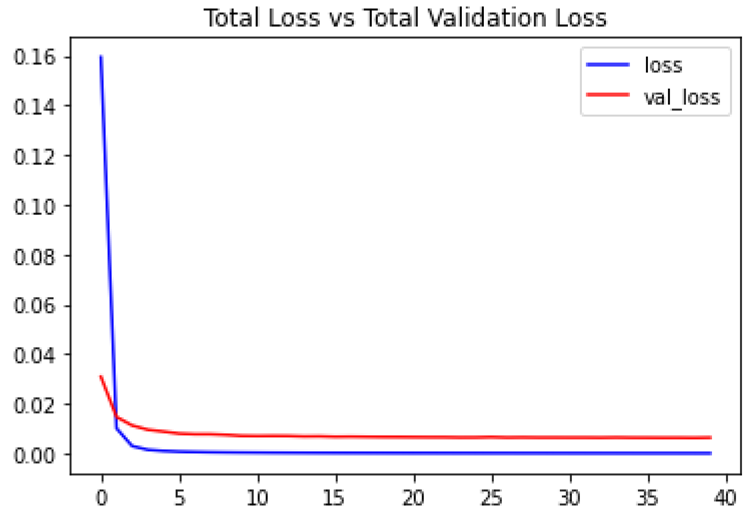
```
[[1604    0    0    0    0    0]
 [   1 1607    2    5    0    0]
 [   0    3 1585    2    1    2]
 [   0    5    2 1578    0    0]
 [   0    0    2    2 1598    0]
 [   0    0    0    0    0 1601]]
```

In [ ]:

```
def plot_metric(metric_name_1, metric_name_2, plot_name):
  # Get Metric values using metric names as identifiers
  metric_value_1 = model_training_history.history[metric_name_1]
  metric_value_2 = model_training_history.history[metric_name_2]

  # Constructing a range object which will be used as time
  epochs = range(len(metric_value_1))

  # Plotting the Graph
  plt.plot(epochs, metric_value_1, 'blue', label = metric_name_1)
  plt.plot(epochs, metric_value_2, 'red', label = metric_name_2)

  # Adding title to the plot
  plt.title(str(plot_name))

  # Adding legend to the plot
  plt.legend()
```

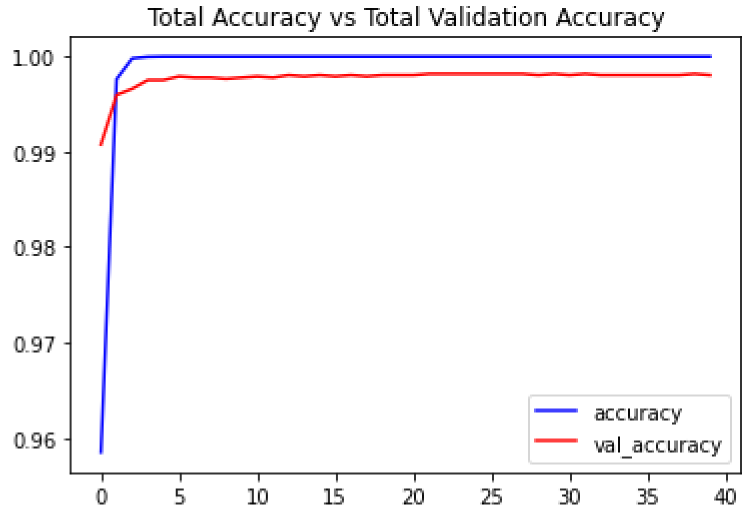
In [ ]:

```
plot_metric('loss', 'val_loss', 'Total Loss vs Total Validation Loss')
```



In ...

```
plot_metric('accuracy', 'val_accuracy', 'Total Accuracy vs Total Validation Accu
```



In [ ]:

```
from collections import Counter

def get_first_mode(a):
    c = Counter(a)
    mode_count = max(c.values())
    mode = {key for key, count in c.items() if count == mode_count}
    first_mode = next(x for x in a if x in mode)
    return first_mode
```

In [ ]:

```
def frames_extraction2(video_path):
    frames_list = []

    vidObj = cv2.VideoCapture(video_path)
    skip_frames=30



    # Used as counter variable
```

In ...

```
#Evaluating a different dataset

from tqdm import tqdm
from statistics import mode


predict = []
actual = []
dataset_directory2="UCF50"

temp_features = []
features = []
labels = []

cc=0

for class_index, class_name in enumerate(classes_list):
    print(f'Extracting Data of Class: {class_name}')

    files_list = os.listdir(os.path.join(dataset_directory2, class_name))

    for file_name in files_list:

        video_file_path = os.path.join(dataset_directory2, class_name, file_name

        frames = frames_extraction2(video_file_path)

        temppred=[]

        for i in frames:
          temppred.append(base_model.predict_classes(np.expand_dims(i, axis = 0)

        print (temppred)
        print ("mode", get_first_mode(temppred), cc)
        cc+=1
        predict.append(get_first_mode(temppred))
        actual.append(class_index)
```

```
Extracting Data of Class: pullup
Defected frame
/usr/local/lib/python3.7/dist-packages/tensorflow/python/keras/engine/sequential.py:
455: UserWarning: `model.predict_classes()` is deprecated and will be removed after
2021-01-01. Please use instead:* `np.argmax(model.predict(x), axis=-1)`,   if your m
odel does multi-class classification   (e.g. if it uses a `softmax` last-layer activ
ation).* `(model.predict(x) > 0.5).astype("int32")`,   if your model does binary cla
ssification   (e.g. if it uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
[0, 0, 0, 0, 0, 5, 0]
mode 0 0
Defected frame
[0, 3, 2, 3, 2, 2]
mode 2 1
Defected frame
[2, 2, 2, 2, 2, 2, 2, 1]
mode 2 2
Defected frame
```

In [26]:

```
print(classification_report(actual, predict))
```

```
              precision    recall  f1-score   support

           0       0.91      0.57      0.70       120
           1       0.62      0.28      0.39       160
           2       0.47      0.96      0.63       153
           3       0.31      0.21      0.25       111
           4       0.70      0.83      0.76       145
           5       0.76      0.66      0.71       142

    accuracy                           0.60       831
   macro avg       0.63      0.59      0.57       831
weighted avg       0.63      0.60      0.58       831
```

In [27]:

```
print(confusion_matrix(actual, predict))
```

```
[[ 68   9  16   9  11   7]
 [  5  45  60  34  14   2]
 [  0   2 147   0   4   0]
 [  1  12  44  23  15  16]
 [  0   1  18   1 121   4]
 [  1   3  29   8   7  94]]
```