MobileNet Model

Action Classes - 20

In [1]:
```
from keras import models
from keras.layers import Dense,Flatten
from keras import backend as K
import numpy as np
import matplotlib.pyplot as plt

from keras.applications import mobilenet
```

In [2]:
```
import tensorflow as tf
print("Num GPUs Available: ", len(tf.config.list_physical_devices('G
```

```
Num GPUs Available:  1

2022-08-25 19:35:53.577594: I tensorflow/stream_executor/cuda/cuda_
gpu_executor.cc:975] successful NUMA node read from SysFS had negat
ive value (-1), but there must be at least one NUMA node, so return
ing NUMA node zero
2022-08-25 19:35:53.679746: I tensorflow/stream_executor/cuda/cuda_
gpu_executor.cc:975] successful NUMA node read from SysFS had negat
ive value (-1), but there must be at least one NUMA node, so return
ing NUMA node zero
2022-08-25 19:35:53.680075: I tensorflow/stream_executor/cuda/cuda_
gpu_executor.cc:975] successful NUMA node read from SysFS had negat
ive value (-1), but there must be at least one NUMA node, so return
ing NUMA node zero
```

Dataset

In [3]:
```
from keras.preprocessing.image import ImageDataGenerator

dataset_path = "./frames/"
# will contain the categories in respective folders

# Data generators
train_datagen = ImageDataGenerator(rescale=1/255, validation_split=0.
```

In [4]:

```
image_size = (224,224)
batch_size = 10

train_batches = train_datagen.flow_from_directory(
    dataset_path,
    target_size = image_size,
    batch_size = batch_size,
    class_mode = "categorical",
    subset = "training"
)

validation_batches = train_datagen.flow_from_directory(
    dataset_path,
    target_size = image_size,
    batch_size = batch_size,
    class_mode = "categorical",
    subset = "validation"
)

test_batches = train_datagen.flow_from_directory(
    dataset_path,
    target_size = image_size,
    batch_size = batch_size,
    class_mode = "categorical",
    subset = "validation"
)
```

```
Found 5118 images belonging to 20 classes.
Found 1270 images belonging to 20 classes.
Found 1270 images belonging to 20 classes.
```

In [5]:

```
train_batches.class_indices
```

Out[5]:

```
{'ApplyLipstick': 0,
 'Archery': 1,
 'BabyCrawling': 2,
 'Basketball': 3,
 'Biking': 4,
 'Diving': 5,
 'Fencing': 6,
 'IceDancing': 7,
 'Kayaking': 8,
 'MilitaryParade': 9,
 'PizzaTossing': 10,
 'PullUps': 11,
 'ShavingBeard': 12,
 'SkateBoarding': 13,
 'SumoWrestling': 14,
 'Surfing': 15,
 'TennisSwing': 16,
 'Typing': 17,
 'WritingOnBoard': 18,
 'YoYo': 19}
```

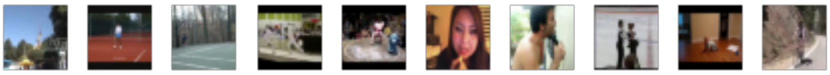
In [6]:

```
from matplotlib import pyplot as plt

def plot_images(images_arr):
    fig, axes = plt.subplots(1,10)
    axes = axes.flatten()
    for img, ax in zip(images_arr, axes):
        ax.imshow(img)
        ax.axis('off')
    plt.tight_layout()
    plt.show()
```

In [7]:

```
imgs, labels = train_batches[0]
plot_images(imgs)
print(labels[:10])
```



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

Initialize model

In [8]:

```
mobilenet_model_top = mobilenet.MobileNet(include_top=True,
                    input_shape=(224,224,3),
                    pooling='avg',
                    weights='imagenet')

for (i,layer) in enumerate(mobilenet_model_top.layers):
    print((i, layer.name, layer.output_shape))
```

```
2022-08-25 19:35:54.974822: I tensorflow/core/platform/cpu_feature_
guard.cc:193] This TensorFlow binary is optimized with oneAPI Deep
Neural Network Library (oneDNN) to use the following CPU instructio
ns in performance-critical operations:  AVX2 FMA
To enable them in other operations, rebuild TensorFlow with the app
ropriate compiler flags.
2022-08-25 19:35:54.975841: I tensorflow/stream_executor/cuda/cuda_
gpu_executor.cc:975] successful NUMA node read from SysFS had negat
ive value (-1), but there must be at least one NUMA node, so return
ing NUMA node zero
2022-08-25 19:35:54.976473: I tensorflow/stream_executor/cuda/cuda_
gpu_executor.cc:975] successful NUMA node read from SysFS had negat
ive value (-1), but there must be at least one NUMA node, so return
ing NUMA node zero
2022-08-25 19:35:54.976814: I tensorflow/stream_executor/cuda/cuda_
gpu_executor.cc:975] successful NUMA node read from SysFS had negat
ive value (-1), but there must be at least one NUMA node, so return
ing NUMA node zero
2022-08-25 19:35:56.108392: I tensorflow/stream_executor/cuda/cuda_
gpu_executor.cc:975] successful NUMA node read from SysFS had negat
```

In [9]:
```
mobilenet_model = mobilenet.MobileNet(include_top=False,
                  input_shape=(224,224,3),
                  pooling='avg',classes=20,
                  weights='imagenet')

for (i,layer) in enumerate(mobilenet_model.layers):
    layer.trainable = False
    print((i, layer.name, layer.output_shape))
```

```
(0, 'input_2', [(None, 224, 224, 3)])
(1, 'conv1', (None, 112, 112, 32))
(2, 'conv1_bn', (None, 112, 112, 32))
(3, 'conv1_relu', (None, 112, 112, 32))
(4, 'conv_dw_1', (None, 112, 112, 32))
(5, 'conv_dw_1_bn', (None, 112, 112, 32))
(6, 'conv_dw_1_relu', (None, 112, 112, 32))
(7, 'conv_pw_1', (None, 112, 112, 64))
(8, 'conv_pw_1_bn', (None, 112, 112, 64))
(9, 'conv_pw_1_relu', (None, 112, 112, 64))
(10, 'conv_pad_2', (None, 113, 113, 64))
(11, 'conv_dw_2', (None, 56, 56, 64))
(12, 'conv_dw_2_bn', (None, 56, 56, 64))
(13, 'conv_dw_2_relu', (None, 56, 56, 64))
(14, 'conv_pw_2', (None, 56, 56, 128))
(15, 'conv_pw_2_bn', (None, 56, 56, 128))
(16, 'conv_pw_2_relu', (None, 56, 56, 128))
(17, 'conv_dw_3', (None, 56, 56, 128))
(18, 'conv_dw_3_bn', (None, 56, 56, 128))
(19, 'conv_dw_3_relu', (None, 56, 56, 128))
(20, 'conv_pw_3', (None, 56, 56, 128))
(21, 'conv_pw_3_bn', (None, 56, 56, 128))
(22, 'conv_pw_3_relu', (None, 56, 56, 128))
(23, 'conv_pad_4', (None, 57, 57, 128))
(24, 'conv_dw_4', (None, 28, 28, 128))
(25, 'conv_dw_4_bn', (None, 28, 28, 128))
(26, 'conv_dw_4_relu', (None, 28, 28, 128))
(27, 'conv_pw_4', (None, 28, 28, 256))
(28, 'conv_pw_4_bn', (None, 28, 28, 256))
(29, 'conv_pw_4_relu', (None, 28, 28, 256))
(30, 'conv_dw_5', (None, 28, 28, 256))
(31, 'conv_dw_5_bn', (None, 28, 28, 256))
(32, 'conv_dw_5_relu', (None, 28, 28, 256))
(33, 'conv_pw_5', (None, 28, 28, 256))
(34, 'conv_pw_5_bn', (None, 28, 28, 256))
(35, 'conv_pw_5_relu', (None, 28, 28, 256))
(36, 'conv_pad_6', (None, 29, 29, 256))
(37, 'conv_dw_6', (None, 14, 14, 256))
(38, 'conv_dw_6_bn', (None, 14, 14, 256))
(39, 'conv_dw_6_relu', (None, 14, 14, 256))
(40, 'conv_pw_6', (None, 14, 14, 512))
(41, 'conv_pw_6_bn', (None, 14, 14, 512))
(42, 'conv_pw_6_relu', (None, 14, 14, 512))
(43, 'conv_dw_7', (None, 14, 14, 512))
(44, 'conv_dw_7_bn', (None, 14, 14, 512))
(45, 'conv_dw_7_relu', (None, 14, 14, 512))
(46, 'conv_pw_7', (None, 14, 14, 512))
(47, 'conv_pw_7_bn', (None, 14, 14, 512))
(48, 'conv_pw_7_relu', (None, 14, 14, 512))
(49, 'conv_dw_8', (None, 14, 14, 512))
```

```
(50, 'conv_dw_8_bn', (None, 14, 14, 512))
(51, 'conv_dw_8_relu', (None, 14, 14, 512))
(52, 'conv_pw_8', (None, 14, 14, 512))
(53, 'conv_pw_8_bn', (None, 14, 14, 512))
(54, 'conv_pw_8_relu', (None, 14, 14, 512))
(55, 'conv_dw_9', (None, 14, 14, 512))
(56, 'conv_dw_9_bn', (None, 14, 14, 512))
(57, 'conv_dw_9_relu', (None, 14, 14, 512))
(58, 'conv_pw_9', (None, 14, 14, 512))
(59, 'conv_pw_9_bn', (None, 14, 14, 512))
(60, 'conv_pw_9_relu', (None, 14, 14, 512))
(61, 'conv_dw_10', (None, 14, 14, 512))
(62, 'conv_dw_10_bn', (None, 14, 14, 512))
(63, 'conv_dw_10_relu', (None, 14, 14, 512))
(64, 'conv_pw_10', (None, 14, 14, 512))
(65, 'conv_pw_10_bn', (None, 14, 14, 512))
(66, 'conv_pw_10_relu', (None, 14, 14, 512))
(67, 'conv_dw_11', (None, 14, 14, 512))
(68, 'conv_dw_11_bn', (None, 14, 14, 512))
(69, 'conv_dw_11_relu', (None, 14, 14, 512))
(70, 'conv_pw_11', (None, 14, 14, 512))
(71, 'conv_pw_11_bn', (None, 14, 14, 512))
(72, 'conv_pw_11_relu', (None, 14, 14, 512))
(73, 'conv_pad_12', (None, 15, 15, 512))
(74, 'conv_dw_12', (None, 7, 7, 512))
(75, 'conv_dw_12_bn', (None, 7, 7, 512))
(76, 'conv_dw_12_relu', (None, 7, 7, 512))
(77, 'conv_pw_12', (None, 7, 7, 1024))
(78, 'conv_pw_12_bn', (None, 7, 7, 1024))
(79, 'conv_pw_12_relu', (None, 7, 7, 1024))
(80, 'conv_dw_13', (None, 7, 7, 1024))
(81, 'conv_dw_13_bn', (None, 7, 7, 1024))
(82, 'conv_dw_13_relu', (None, 7, 7, 1024))
(83, 'conv_pw_13', (None, 7, 7, 1024))
(84, 'conv_pw_13_bn', (None, 7, 7, 1024))
(85, 'conv_pw_13_relu', (None, 7, 7, 1024))
(86, 'global_average_pooling2d_1', (None, 1024))
```

In [10]:

```
model = models.Sequential()

dense_layer_1 = Dense(32, activation='relu')
dense_layer_2 = Dense(32, activation='relu')
dense_layer_2 = Dense(32, activation='relu')
prediction_layer = Dense(20, activation='softmax')

model.add(mobilenet_model)
model.add(dense_layer_1)
model.add(dense_layer_2)
model.add(prediction_layer)

model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 mobilenet_1.00_224 (Functio  (None, 1024)             3228864   
 nal)                                                            
                                                                 
 dense (Dense)               (None, 32)                32800     
                                                                 
 dense_2 (Dense)             (None, 32)                1056      
                                                                 
 dense_3 (Dense)             (None, 20)                660       
                                                                 
=================================================================
Total params: 3,263,380
Trainable params: 34,516
Non-trainable params: 3,228,864
_________________________________________________________________
```

In [11]:

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

In [12]:

```
model.save("./models/action-class-20-model-mobilenet.h5")
```

In [13]:
```
fit = model.fit(train_batches, epochs=20, validation_data=validation_
```

```
Epoch 1/20

2022-08-25 19:36:01.438879: I tensorflow/stream_executor/cuda/cuda_
dnn.cc:384] Loaded cuDNN version 8401
2022-08-25 19:36:02.831912: I tensorflow/core/platform/default/subp
rocess.cc:304] Start cannot spawn child process: No such file or di
rectory

512/512 [==============================] - 65s 117ms/step - loss:
0.9352 - accuracy: 0.7386 - val_loss: 0.5429 - val_accuracy: 0.8087
Epoch 2/20
512/512 [==============================] - 18s 34ms/step - loss: 0.
1710 - accuracy: 0.9547 - val_loss: 0.5272 - val_accuracy: 0.8417
Epoch 3/20
512/512 [==============================] - 18s 35ms/step - loss: 0.
0727 - accuracy: 0.9867 - val_loss: 0.4083 - val_accuracy: 0.8685
Epoch 4/20
512/512 [==============================] - 18s 35ms/step - loss: 0.
0401 - accuracy: 0.9916 - val_loss: 0.4940 - val_accuracy: 0.8417
Epoch 5/20
512/512 [==============================] - 18s 35ms/step - loss: 0.
0244 - accuracy: 0.9955 - val_loss: 0.6585 - val_accuracy: 0.8094
Epoch 6/20
512/512 [==============================] - 18s 36ms/step - loss: 0.
0120 - accuracy: 0.9990 - val_loss: 0.5133 - val_accuracy: 0.8559
Epoch 7/20
512/512 [==============================] - 19s 37ms/step - loss: 0.
0062 - accuracy: 0.9992 - val_loss: 0.6023 - val_accuracy: 0.8346
Epoch 8/20
512/512 [==============================] - 20s 38ms/step - loss: 0.
0032 - accuracy: 0.9998 - val_loss: 0.4216 - val_accuracy: 0.8772
Epoch 9/20
512/512 [==============================] - 22s 43ms/step - loss: 0.
0016 - accuracy: 1.0000 - val_loss: 0.4102 - val_accuracy: 0.8827
Epoch 10/20
512/512 [==============================] - 23s 45ms/step - loss: 0.
0012 - accuracy: 1.0000 - val_loss: 0.4188 - val_accuracy: 0.8835
Epoch 11/20
512/512 [==============================] - 28s 54ms/step - loss: 9.
0547e-04 - accuracy: 1.0000 - val_loss: 0.4368 - val_accuracy: 0.88
66
Epoch 12/20
512/512 [==============================] - 28s 55ms/step - loss: 6.
5826e-04 - accuracy: 1.0000 - val_loss: 0.4334 - val_accuracy: 0.88
66
Epoch 13/20
512/512 [==============================] - 30s 59ms/step - loss: 5.
1006e-04 - accuracy: 1.0000 - val_loss: 0.4446 - val_accuracy: 0.88
74
Epoch 14/20
512/512 [==============================] - 29s 57ms/step - loss: 3.
8705e-04 - accuracy: 1.0000 - val_loss: 0.4590 - val_accuracy: 0.87
87
Epoch 15/20
512/512 [==============================] - 31s 61ms/step - loss: 2.
9346e-04 - accuracy: 1.0000 - val_loss: 0.4573 - val_accuracy: 0.88
43
Epoch 16/20
```

```
512/512 [==============================] - 31s 61ms/step - loss: 2.
1782e-04 - accuracy: 1.0000 - val_loss: 0.4613 - val_accuracy: 0.88
74
Epoch 17/20
512/512 [==============================] - 36s 70ms/step - loss: 1.
6509e-04 - accuracy: 1.0000 - val_loss: 0.4718 - val_accuracy: 0.88
82
Epoch 18/20
512/512 [==============================] - 32s 63ms/step - loss: 1.
2522e-04 - accuracy: 1.0000 - val_loss: 0.4602 - val_accuracy: 0.88
98
Epoch 19/20
512/512 [==============================] - 32s 62ms/step - loss: 9.
2589e-05 - accuracy: 1.0000 - val_loss: 0.4771 - val_accuracy: 0.88
98
Epoch 20/20
512/512 [==============================] - 32s 63ms/step - loss: 7.
0955e-05 - accuracy: 1.0000 - val_loss: 0.4960 - val_accuracy: 0.88
58
```

In [14]:

```
model.save("./models/action-class-20-trained-mobilenet.h5")
```

Evaluate and Predict

In [15]:

```
model = models.load_model("./models/action-class-20-trained-mobilenet
model.summary()
```

```
Model: "sequential"

_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 mobilenet_1.00_224 (Functio  (None, 1024)             3228864   
 nal)                                                            
                                                                 
 dense (Dense)               (None, 32)                32800     
                                                                 
 dense_2 (Dense)             (None, 32)                1056      
                                                                 
 dense_3 (Dense)             (None, 20)                660       
                                                                 
=================================================================
Total params: 3,263,380
Trainable params: 34,516
Non-trainable params: 3,228,864
_________________________________________________________________
```

In [16]:

```
model.evaluate(test_batches)
```

```
127/127 [==============================] - 10s 69ms/step - loss: 0.
4960 - accuracy: 0.8858
```

Out[16]:

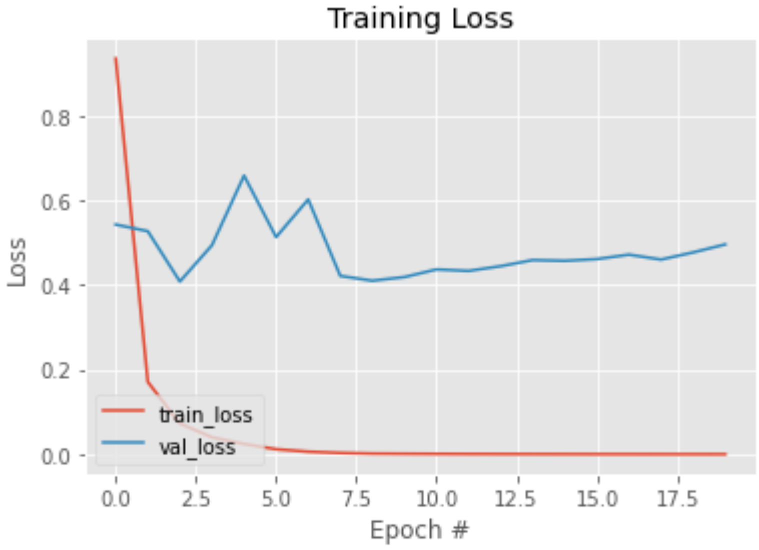
```
[0.49597105383872986, 0.8858267664909363]
```

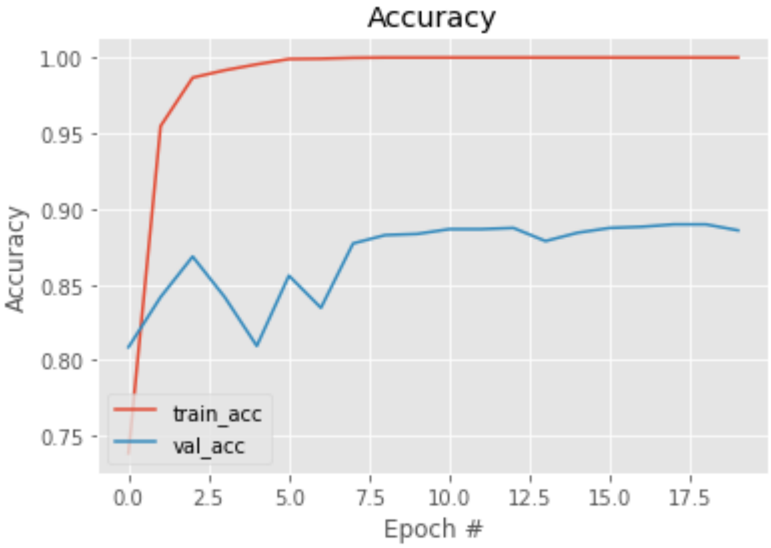
In [17]:

```
plt.style.use("ggplot")
plt.figure()

plt.plot(np.arange(0, 20), fit.history["loss"], label="train_loss")
plt.plot(np.arange(0, 20), fit.history["val_loss"], label="val_loss"
plt.title("Training Loss")
plt.xlabel("Epoch #")
plt.ylabel("Loss")
plt.legend(loc="lower left")
plt.show()

plt.plot(np.arange(0, 20), fit.history["accuracy"], label="train_acc
plt.plot(np.arange(0, 20), fit.history["val_accuracy"], label="val_ac
plt.title("Accuracy")
plt.xlabel("Epoch #")
plt.ylabel("Accuracy")
plt.legend(loc="lower left")
plt.show()
```





In [19]:

```
print("Avg Val Acc: " + str(sum(fit.history["val_accuracy"])/20*100))
print("Avg Val Loss: " + str(sum(fit.history["val_loss"])/20*100))
```

```
Avg Val Acc: 86.8425190448761
Avg Val Loss: 47.973386347293854
```