

```
In [1]: import numpy as np
import matplotlib.pyplot as plt
import tensorflow as tf
from tensorflow.python.keras.layers import Dense, GlobalAveragePooling2D
from tensorflow.python.keras.models import Model
from tensorflow.python.keras import layers, Sequential, losses, metrics

image_height = 48
image_width = 48
emotions_count = 8
emotion_labels = ['neutral', 'happiness', 'surprise', 'sadness',
                  'anger', 'disgust', 'fear', 'contempt']

samples = 35393 # 2~35394
training_samples = 28317 # 2~28318 (Training)
validation_samples = 3541 # 28319~31859 (PublicTest)
test_samples = 3535 # 31860~35394 (PrivateTest)
expw_samples = 91793

image_path = "./dataset/images.npy"
emotion_path = "./dataset/emotions_multi.npy"
image_path_expw = "./AffectNet/images.npy"
emotion_path_expw = "./AffectNet/emotions.npy"
```

```
2021-12-26 16:36:37.902662: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcudart.so.11.0
```

```
In [2]: images = np.load(image_path)
emotions = np.load(emotion_path)
images_expw = np.load(image_path_expw)
emotions_expw = np.load(emotion_path_expw)
print(images.shape)
print(emotions.shape)
print(images_expw.shape)
print(emotions_expw.shape)
```

```
(35393, 48, 48, 1)
(35393, 8)
(291648, 48, 48, 3)
(291648, 8)
```

```
In [3]: tf.config.run_functions_eagerly(True)
def model_acc(y_true, y_pred):
    size = y_true.shape[0]
    acc = 0
    for i in range(size):
        true = y_true[i]
        pred = y_pred[i]
        index_max = tf.argmax(pred).numpy()
        if true[index_max].numpy()==tf.reduce_max(true).numpy():
            acc += 1
    return acc/size
```

```
In [4]: images_expw = tf.convert_to_tensor(images_expw)
images = tf.image.grayscale_to_rgb(tf.convert_to_tensor(images))
images = tf.cast(images, tf.uint8)
```

```
2021-12-26 16:36:43.095274: I tensorflow/compiler/jit/xla_cpu_device.cc:41] Not creating XLA devices, tf_xla_enable_xla_devices not set
2021-12-26 16:36:43.096892: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcuda.so.1
2021-12-26 16:36:43.163988: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:941] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2021-12-26 16:36:43.164494: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1720] Found device 0 with properties:
pciBusID: 0000:05:00.0 name: GeForce RTX 2080 Ti computeCapability: 7.5
coreClock: 1.545GHz coreCount: 68 deviceMemorySize: 10.76GiB deviceMemoryBandwidth: 573.69GiB/s
2021-12-26 16:36:43.164529: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcudart.so.11.0
2021-12-26 16:36:43.169316: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcublas.so.11
2021-12-26 16:36:43.169388: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcublasLt.so.11
2021-12-26 16:36:43.172049: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcufft.so.10
2021-12-26 16:36:43.173319: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcurand.so.10
2021-12-26 16:36:43.179372: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcusolver.so.10
2021-12-26 16:36:43.181438: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcusparse.so.11
2021-12-26 16:36:43.182458: I tensorflow/stream_executor/platform/default/dso_loader.cc:49] Successfully opened dynamic library libcudnn.so.8
2021-12-26 16:36:43.182606: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:941] successful NUMA node read from SysFS had n
```

```

egative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2021-12-26 16:36:43.927949: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:941] successful NUMA node read from SysFS had n
egative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2021-12-26 16:36:43.928369: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1406] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 10071 MB memory) -> physical GPU (device: 0, name: GeForce RTX 2080 Ti, pci bus id: 0000:05:00.0,
compute capability: 7.5)
2021-12-26 16:36:43.929856: W tensorflow/core/framework/cpu_allocator_impl.cc:80] Allocation of 2015870976 exceeds 10% of free sys
tem memory.

```

In [5]:

```

print(images.shape)
print(emotions.shape)
print(images_expw.shape)
print(emotions_expw.shape)

```

```

(35393, 48, 48, 3)
(35393, 8)
(291648, 48, 48, 3)
(291648, 8)

```

In [6]:

```

from tensorflow.python.keras.applications import vgg16, resnet_v2
from tensorflow.python.keras import optimizers
from tensorflow.python.keras.optimizer_v2 import adam
import matplotlib.pyplot as plt

cce = losses.CategoricalCrossentropy()
mse = losses.MeanSquaredError()

```

In [7]:

```

training_size = training_samples + validation_samples
print(images[:training_size].shape)
print(emotions[:training_size].shape)
print(images[training_size:].shape)
print(emotions[training_size:].shape)

```

```

(31858, 48, 48, 3)
(31858, 8)
(3535, 48, 48, 3)
(3535, 8)

```

In [8]:

```

base_model = vgg16.VGG16(include_top=False,
                          weights="imagenet",

```

```

        input_shape=(48,48,3))

base_model.trainable=True
model = Sequential([
    base_model,
    layers.GlobalAveragePooling2D(),
    layers.Dense(4096, activation='relu'),
    layers.Dense(4096, activation='relu'),
    layers.Dense(emotions_count, activation='softmax'),
])

model.compile(optimizer=adam.Adam(learning_rate=1e-5),
              loss=mse,
              metrics = [model_acc])
model.fit(x=images_expw,
          y=emotions_expw,
          batch_size=32,
          epochs=40)

```

/userhome/cs/fym666/anaconda3/envs/tensorflow/lib/python3.8/site-packages/tensorflow/python/data/ops/dataset\_ops.py:3503: UserWarning: Even though the tf.config.experimental\_run\_functions\_eagerly option is set, this option does not apply to tf.data functions. tf.data functions are still traced and executed as graphs.

warnings.warn(

2021-12-26 16:36:47.178701: I tensorflow/compiler/mlir/mlir\_graph\_optimization\_pass.cc:116] None of the MLIR optimization passes are enabled (registered 2)

2021-12-26 16:36:47.179633: I tensorflow/core/platform/profile\_utils/cpu\_utils.cc:112] CPU Frequency: 2199995000 Hz

2021-12-26 16:36:47.223423: I tensorflow/stream\_executor/platform/default/dso\_loader.cc:49] Successfully opened dynamic library libcudnn.so.8

Epoch 1/40

2021-12-26 16:36:49.715566: I tensorflow/stream\_executor/platform/default/dso\_loader.cc:49] Successfully opened dynamic library libcublas.so.11

2021-12-26 16:36:50.336645: I tensorflow/stream\_executor/platform/default/dso\_loader.cc:49] Successfully opened dynamic library libcublasLt.so.11

9114/9114 [=====] - 723s 79ms/step - loss: 0.0628 - model\_acc: 0.6286

Epoch 2/40

9114/9114 [=====] - 739s 81ms/step - loss: 0.0488 - model\_acc: 0.7204

Epoch 3/40

9114/9114 [=====] - 746s 82ms/step - loss: 0.0452 - model\_acc: 0.7436

Epoch 4/40

9114/9114 [=====] - 733s 80ms/step - loss: 0.0420 - model\_acc: 0.7640

Epoch 5/40

9114/9114 [=====] - 745s 82ms/step - loss: 0.0388 - model\_acc: 0.7864

Epoch 6/40

9114/9114 [=====] - 735s 81ms/step - loss: 0.0354 - model\_acc: 0.8080

```
Epoch 7/40
9114/9114 [=====] - 727s 80ms/step - loss: 0.0320 - model_acc: 0.8288
Epoch 8/40
9114/9114 [=====] - 735s 81ms/step - loss: 0.0287 - model_acc: 0.8492
Epoch 9/40
9114/9114 [=====] - 710s 78ms/step - loss: 0.0257 - model_acc: 0.8668
Epoch 10/40
9114/9114 [=====] - 716s 79ms/step - loss: 0.0234 - model_acc: 0.8794
Epoch 11/40
9114/9114 [=====] - 721s 79ms/step - loss: 0.0212 - model_acc: 0.8919
Epoch 12/40
9114/9114 [=====] - 733s 80ms/step - loss: 0.0196 - model_acc: 0.9007
Epoch 13/40
9114/9114 [=====] - 703s 77ms/step - loss: 0.0183 - model_acc: 0.9081
Epoch 14/40
9114/9114 [=====] - 740s 81ms/step - loss: 0.0170 - model_acc: 0.9143
Epoch 15/40
9114/9114 [=====] - 726s 80ms/step - loss: 0.0162 - model_acc: 0.9191
Epoch 16/40
9114/9114 [=====] - 725s 79ms/step - loss: 0.0153 - model_acc: 0.9236
Epoch 17/40
9114/9114 [=====] - 734s 81ms/step - loss: 0.0145 - model_acc: 0.9280
Epoch 18/40
9114/9114 [=====] - 728s 80ms/step - loss: 0.0138 - model_acc: 0.9313
Epoch 19/40
9114/9114 [=====] - 729s 80ms/step - loss: 0.0132 - model_acc: 0.9345
Epoch 20/40
9114/9114 [=====] - 737s 81ms/step - loss: 0.0127 - model_acc: 0.9371
Epoch 21/40
9114/9114 [=====] - 732s 80ms/step - loss: 0.0123 - model_acc: 0.9389
Epoch 22/40
9114/9114 [=====] - 739s 81ms/step - loss: 0.0118 - model_acc: 0.9418
Epoch 23/40
9114/9114 [=====] - 738s 81ms/step - loss: 0.0113 - model_acc: 0.9445
Epoch 24/40
9114/9114 [=====] - 734s 80ms/step - loss: 0.0109 - model_acc: 0.9462
Epoch 25/40
9114/9114 [=====] - 729s 80ms/step - loss: 0.0104 - model_acc: 0.9491
Epoch 26/40
9114/9114 [=====] - 737s 81ms/step - loss: 0.0102 - model_acc: 0.9503
Epoch 27/40
9114/9114 [=====] - 730s 80ms/step - loss: 0.0098 - model_acc: 0.9524
Epoch 28/40
1463/9114 [==>.....] - ETA: 10:11 - loss: 0.0090 - model_acc: 0.9566
```

In [9]:

```

model.compile(optimizer=adam.Adam(learning_rate=1e-4),
              loss=mse,
              metrics = [model_acc])

model.fit(x=images[:training_samples],
          y=emotions[:training_samples],
          batch_size=32,
          epochs=30,
          validation_data=(images[training_samples:], emotions[training_samples:]))

```

Epoch 1/30

885/885 [=====] - 81s 92ms/step - loss: 0.0281 - model\_acc: 0.7069 - val\_loss: 0.0188 - val\_model\_acc: 0.7811

Epoch 2/30

885/885 [=====] - 76s 86ms/step - loss: 0.0151 - model\_acc: 0.8153 - val\_loss: 0.0176 - val\_model\_acc: 0.7972

Epoch 3/30

885/885 [=====] - 77s 87ms/step - loss: 0.0112 - model\_acc: 0.8566 - val\_loss: 0.0161 - val\_model\_acc: 0.8049

Epoch 4/30

885/885 [=====] - 82s 93ms/step - loss: 0.0093 - model\_acc: 0.8818 - val\_loss: 0.0148 - val\_model\_acc: 0.8195

Epoch 5/30

885/885 [=====] - 82s 93ms/step - loss: 0.0072 - model\_acc: 0.9072 - val\_loss: 0.0153 - val\_model\_acc: 0.8183

Epoch 6/30

885/885 [=====] - 82s 93ms/step - loss: 0.0057 - model\_acc: 0.9276 - val\_loss: 0.0162 - val\_model\_acc: 0.8139

Epoch 7/30

885/885 [=====] - 82s 93ms/step - loss: 0.0055 - model\_acc: 0.9260 - val\_loss: 0.0152 - val\_model\_acc: 0.8247

Epoch 8/30

885/885 [=====] - 81s 92ms/step - loss: 0.0049 - model\_acc: 0.9323 - val\_loss: 0.0153 - val\_model\_acc: 0.8259

Epoch 9/30

885/885 [=====] - 82s 93ms/step - loss: 0.0043 - model\_acc: 0.9423 - val\_loss: 0.0140 - val\_model\_acc: 0.8340

Epoch 10/30

885/885 [=====] - 77s 87ms/step - loss: 0.0039 - model\_acc: 0.9487 - val\_loss: 0.0142 - val\_model\_acc: 0.8277

Epoch 11/30

885/885 [=====] - 81s 92ms/step - loss: 0.0037 - model\_acc: 0.9489 - val\_loss: 0.0143 - val\_model\_acc: 0.

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Epoch 12/30
885/885 [=====] - 83s 93ms/step - loss: 0.0039 - model_acc: 0.9455 - val_loss: 0.0140 - val_model_acc: 0.8353
Epoch 13/30
885/885 [=====] - 80s 90ms/step - loss: 0.0030 - model_acc: 0.9601 - val_loss: 0.0136 - val_model_acc: 0.8391
Epoch 14/30
885/885 [=====] - 82s 92ms/step - loss: 0.0025 - model_acc: 0.9685 - val_loss: 0.0136 - val_model_acc: 0.8354
Epoch 15/30
885/885 [=====] - 82s 92ms/step - loss: 0.0026 - model_acc: 0.9606 - val_loss: 0.0136 - val_model_acc: 0.8352
Epoch 16/30
885/885 [=====] - 82s 93ms/step - loss: 0.0024 - model_acc: 0.9658 - val_loss: 0.0141 - val_model_acc: 0.8343
Epoch 17/30
885/885 [=====] - 82s 92ms/step - loss: 0.0034 - model_acc: 0.9507 - val_loss: 0.0139 - val_model_acc: 0.8439
Epoch 18/30
885/885 [=====] - 81s 92ms/step - loss: 0.0021 - model_acc: 0.9695 - val_loss: 0.0133 - val_model_acc: 0.8435
Epoch 19/30
885/885 [=====] - 81s 91ms/step - loss: 0.0016 - model_acc: 0.9782 - val_loss: 0.0133 - val_model_acc: 0.8397
Epoch 20/30
885/885 [=====] - 82s 93ms/step - loss: 0.0020 - model_acc: 0.9718 - val_loss: 0.0137 - val_model_acc: 0.8347
Epoch 21/30
885/885 [=====] - 80s 91ms/step - loss: 0.0020 - model_acc: 0.9692 - val_loss: 0.0135 - val_model_acc: 0.8369
Epoch 22/30
885/885 [=====] - 81s 91ms/step - loss: 0.0017 - model_acc: 0.9771 - val_loss: 0.0166 - val_model_acc: 0.8122
Epoch 23/30
885/885 [=====] - 81s 92ms/step - loss: 0.0028 - model_acc: 0.9630 - val_loss: 0.0135 - val_model_acc: 0.8377
Epoch 24/30
885/885 [=====] - 83s 94ms/step - loss: 0.0012 - model_acc: 0.9848 - val_loss: 0.0133 - val_model_acc: 0.8399
Epoch 25/30
134/885 [==>.....] - ETA: 54s - loss: 9.7892e-04 - model_acc: 0.9922
```

```
~/anaconda3/envs/tensorflow/lib/python3.8/site-packages/tensorflow/python/keras/engine/base_layer.py in __call__(self, *args, **kw
args)
    956
    957     # Accept NumPy and scalar inputs by converting to Tensors.
--> 958     if any(isinstance(x, (
    959         np_arrays.ndarray, np.ndarray, float, int)) for x in input_list):
    960         inputs = nest.map_structure(_convert_numpy_or_python_types, inputs)

~/anaconda3/envs/tensorflow/lib/python3.8/site-packages/tensorflow/python/keras/engine/base_layer.py in <genexpr>(.0)
    957     # Accept NumPy and scalar inputs by converting to Tensors.
    958     if any(isinstance(x, (
--> 959         np_arrays.ndarray, np.ndarray, float, int)) for x in input_list):
    960         inputs = nest.map_structure(_convert_numpy_or_python_types, inputs)
    961         input_list = nest.flatten(inputs)

KeyboardInterrupt:
```

```
In [10]: model.compile(optimizer=adam.Adam(learning_rate=1e-5),
                    loss=mse,
                    metrics = [model_acc])

model.fit(x=images[:training_samples],
          y=emotions[:training_samples],
          batch_size=32,
          epochs=10,
          validation_data=(images[training_samples:], emotions[training_samples:]))
```

Epoch 1/10

885/885 [=====] - 80s 91ms/step - loss: 8.5310e-04 - model\_acc: 0.9924 - val\_loss: 0.0129 - val\_model\_ac  
c: 0.8426

Epoch 2/10

885/885 [=====] - 81s 92ms/step - loss: 5.8835e-04 - model\_acc: 0.9962 - val\_loss: 0.0129 - val\_model\_ac  
c: 0.8418

Epoch 3/10

885/885 [=====] - 81s 92ms/step - loss: 4.7205e-04 - model\_acc: 0.9982 - val\_loss: 0.0129 - val\_model\_ac  
c: 0.8428

Epoch 4/10

885/885 [=====] - 81s 91ms/step - loss: 4.1784e-04 - model\_acc: 0.9982 - val\_loss: 0.0130 - val\_model\_ac  
c: 0.8439

Epoch 5/10

885/885 [=====] - 81s 91ms/step - loss: 3.5351e-04 - model\_acc: 0.9989 - val\_loss: 0.0130 - val\_model\_ac  
c: 0.8414



Epoch 6/10

885/885 [=====] - 70s 79ms/step - loss: 3.2706e-04 - model\_acc: 0.9992 - val\_loss: 0.0130 - val\_model\_acc: 0.8426

Epoch 7/10

885/885 [=====] - 82s 92ms/step - loss: 3.0366e-04 - model\_acc: 0.9992 - val\_loss: 0.0130 - val\_model\_acc: 0.8426

Epoch 8/10

885/885 [=====] - 82s 92ms/step - loss: 2.7316e-04 - model\_acc: 0.9991 - val\_loss: 0.0130 - val\_model\_acc: 0.8425

Epoch 9/10

885/885 [=====] - 84s 95ms/step - loss: 2.4710e-04 - model\_acc: 0.9988 - val\_loss: 0.0130 - val\_model\_acc: 0.8428

Epoch 10/10

885/885 [=====] - 81s 91ms/step - loss: 2.3300e-04 - model\_acc: 0.9992 - val\_loss: 0.0131 - val\_model\_acc: 0.8412

Out[10]: <tensorflow.python.keras.callbacks.History at 0x14dd672038b0>

In [ ]: