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']

#data augmentation: mirror version
samples = 67251 # 2~67252
training_samples = 28317*2  # 2~56635 (Training)
validation_samples = 3541*2 # 56636~63717 (PublicTest)
test_samples = 3535         # 63718~67252 (PrivateTest)

image_path = "./dataset/images.npy"
emotion_multi_path = "./dataset/emotions_multi.npy"
emotion_single_path = "./dataset/emotions_single.npy"
```

In [2]:
```
images = np.load(image_path)
emotions_multi = np.load(emotion_multi_path)
emotions_single = np.load(emotion_single_path)

print(images.shape)
print(emotions_multi.shape)
print(emotions_single.shape)
```

```
(67251, 48, 48, 1)
(67251, 8)
(67251, 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]:

```
#emotions = emotions_single
emotions = emotions_multi

images = tf.convert_to_tensor(images)
images = tf.image.grayscale_to_rgb(images)
emotions = tf.convert_to_tensor(emotions)
# images = tf.image.resize(images, [224,224])
images = layers.Rescaling(1./127.5, offset= -1)(images)

training_size = training_samples + validation_samples
test_size = test_samples

training_images = images[:training_size]
test_images = images[training_size:]
training_emotions = emotions[:training_size]
test_emotions = emotions[training_size:]

print("training_images shape:", training_images.shape)
print("training_emotions shape:", training_emotions.shape)
print("test_images shape:", test_images.shape)
print("test_emotions shape:", test_emotions.shape)
```

```
training_images shape: (63716, 48, 48, 3)
training_emotions shape: (63716, 8)
test_images shape: (3535, 48, 48, 3)
test_emotions shape: (3535, 8)
```

In [5]:

```
from tensorflow.python.keras.applications import vgg16, resnetV2
from tensorflow.python.keras import optimizers
from tensorflow.python.keras.optimizer_v2 import adam
```

In [6]:

```
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-4),
              loss=losses.CategoricalCrossentropy(),
              metrics = [model_acc])

model.fit(x=training_images,
          y=training_emotions,
          batch_size=32,
          epochs=40,
          validation_data=(test_images, test_emotions))
```

```
C:\Users\Darkl\anaconda3\lib\site-packages\tensorflow\python\data\ops\dataset_ops.py:3703: UserWarning: Even though the `tf.c
onfig.experimental_run_functions_eagerly` option is set, this option does not apply to tf.data functions. To force eager exec
ution of tf.data functions, please use `tf.data.experimental.enable.debug_mode()`.
  warnings.warn(
Epoch 1/40
1992/1992 [==============================] - 144s 70ms/step - loss: 1.0905 - model_acc: 0.7159 - val_loss: 0.9279 - val_model
_acc: 0.7776
Epoch 2/40
1992/1992 [==============================] - 136s 68ms/step - loss: 0.8840 - model_acc: 0.8233 - val_loss: 0.8811 - val_model
_acc: 0.8103
Epoch 3/40
1992/1992 [==============================] - 135s 68ms/step - loss: 0.8193 - model_acc: 0.8578 - val_loss: 0.8734 - val_model
_acc: 0.8187
Epoch 4/40
1992/1992 [==============================] - 135s 68ms/step - loss: 0.7778 - model_acc: 0.8814 - val_loss: 0.8449 - val_model
_acc: 0.8363
Epoch 5/40
1992/1992 [==============================] - 137s 69ms/step - loss: 0.7434 - model_acc: 0.9031 - val_loss: 0.8445 - val_model
_acc: 0.8356
Epoch 6/40
1992/1992 [==============================] - 136s 68ms/step - loss: 0.7180 - model_acc: 0.9161 - val_loss: 0.8428 - val_model
_acc: 0.8395
Epoch 7/40
1992/1992 [==============================] - 136s 68ms/step - loss: 0.6944 - model_acc: 0.9289 - val_loss: 0.8361 - val_model
_acc: 0.8410
```

```
Epoch 8/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.6721 - model_acc: 0.9356 - val_loss: 0.8632 - val_model
_acc: 0.8354
Epoch 9/40
1992/1992 [==============================] - 136s 68ms/step - loss: 0.6521 - model_acc: 0.9422 - val_loss: 0.8630 - val_model
_acc: 0.8453
Epoch 10/40
1992/1992 [==============================] - 137s 69ms/step - loss: 0.6343 - model_acc: 0.9459 - val_loss: 0.8789 - val_model
_acc: 0.8433
Epoch 11/40
1992/1992 [==============================] - 137s 69ms/step - loss: 0.6179 - model_acc: 0.9505 - val_loss: 0.8987 - val_model
_acc: 0.8421
Epoch 12/40
1992/1992 [==============================] - 139s 70ms/step - loss: 0.6058 - model_acc: 0.9533 - val_loss: 0.9149 - val_model
_acc: 0.8401
Epoch 13/40
1992/1992 [==============================] - 142s 71ms/step - loss: 0.5964 - model_acc: 0.9535 - val_loss: 0.9412 - val_model
_acc: 0.8444
Epoch 14/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5885 - model_acc: 0.9582 - val_loss: 0.9545 - val_model
_acc: 0.8348
Epoch 15/40
1992/1992 [==============================] - 142s 71ms/step - loss: 0.5835 - model_acc: 0.9571 - val_loss: 0.9544 - val_model
_acc: 0.8444
Epoch 16/40
1992/1992 [==============================] - 139s 70ms/step - loss: 0.5787 - model_acc: 0.9595 - val_loss: 0.9625 - val_model
_acc: 0.8373
Epoch 17/40
1992/1992 [==============================] - 139s 70ms/step - loss: 0.5761 - model_acc: 0.9601 - val_loss: 0.9987 - val_model
_acc: 0.8450
Epoch 18/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5723 - model_acc: 0.9618 - val_loss: 1.0044 - val_model
_acc: 0.8464
Epoch 19/40
1992/1992 [==============================] - 139s 70ms/step - loss: 0.5709 - model_acc: 0.9609 - val_loss: 1.0407 - val_model
_acc: 0.8455
Epoch 20/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5684 - model_acc: 0.9627 - val_loss: 1.0260 - val_model
_acc: 0.8419
Epoch 21/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5674 - model_acc: 0.9635 - val_loss: 1.0182 - val_model
_acc: 0.8430
Epoch 22/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5653 - model_acc: 0.9645 - val_loss: 1.0540 - val_model
```

```
_acc: 0.8427
Epoch 23/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5642 - model_acc: 0.9658 - val_loss: 1.0247 - val_model
_acc: 0.8416
Epoch 24/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5629 - model_acc: 0.9647 - val_loss: 1.0387 - val_model
_acc: 0.8449
Epoch 25/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5620 - model_acc: 0.9663 - val_loss: 1.0696 - val_model
_acc: 0.8459
Epoch 26/40
1992/1992 [==============================] - 139s 70ms/step - loss: 0.5605 - model_acc: 0.9669 - val_loss: 1.0297 - val_model
_acc: 0.8413
Epoch 27/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5600 - model_acc: 0.9675 - val_loss: 1.0873 - val_model
_acc: 0.8459
Epoch 28/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5583 - model_acc: 0.9691 - val_loss: 1.1067 - val_model
_acc: 0.8428
Epoch 29/40
1992/1992 [==============================] - 139s 70ms/step - loss: 0.5581 - model_acc: 0.9684 - val_loss: 1.0764 - val_model
_acc: 0.8433
Epoch 30/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5576 - model_acc: 0.9689 - val_loss: 1.0555 - val_model
_acc: 0.8413
Epoch 31/40
1992/1992 [==============================] - 138s 70ms/step - loss: 0.5569 - model_acc: 0.9691 - val_loss: 1.0920 - val_model
_acc: 0.8342
Epoch 32/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5567 - model_acc: 0.9687 - val_loss: 1.1048 - val_model
_acc: 0.8512
Epoch 33/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5550 - model_acc: 0.9719 - val_loss: 1.1038 - val_model
_acc: 0.8401
Epoch 34/40
1992/1992 [==============================] - 140s 70ms/step - loss: 0.5549 - model_acc: 0.9708 - val_loss: 1.0951 - val_model
_acc: 0.8407
Epoch 35/40
1992/1992 [==============================] - 137s 69ms/step - loss: 0.5538 - model_acc: 0.9717 - val_loss: 1.1103 - val_model
_acc: 0.8427
Epoch 36/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5532 - model_acc: 0.9721 - val_loss: 1.1232 - val_model
_acc: 0.8421
Epoch 37/40
```

```
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5532 - model_acc: 0.9725 - val_loss: 1.0939 - val_model
_acc: 0.8348
Epoch 38/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5542 - model_acc: 0.9714 - val_loss: 1.0842 - val_model
_acc: 0.8429
Epoch 39/40
1992/1992 [==============================] - 138s 69ms/step - loss: 0.5522 - model_acc: 0.9743 - val_loss: 1.0871 - val_model
_acc: 0.8467
Epoch 40/40
1992/1992 [==============================] - 141s 71ms/step - loss: 0.5506 - model_acc: 0.9752 - val_loss: 1.0999 - val_model
_acc: 0.8405
```

Out[6]:
```
<tensorflow.python.keras.callbacks.History at 0x2c880a6d730>
```

In [9]:
```
base_model = tf.keras.applications.ResNet101V2(include_top=False,
                        weights="imagenet",
                        input_shape=(48,48,3))
base_model.trainable=True
model = Sequential([
    base_model,
    layers.GlobalAveragePooling2D(),
    layers.Dense(2048, activation='relu'),
    layers.Dense(2048, activation='relu'),
    layers.Dense(emotions_count, activation='softmax'),
])

model.compile(optimizer=adam.Adam(learning_rate=1e-3),
              loss=losses.CategoricalCrossentropy(),
              metrics = [model_acc])

model.fit(x=training_images,
          y=training_emotions,
          batch_size=32,
          epochs=40,
          validation_data=(test_images, test_emotions))
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/resnet/resnet101v2_weights_tf_dim_ordering
_tf_kernels_notop.h5
171319296/171317808 [==============================] - 2s 0us/step
Epoch 1/40
  92/1992 [>.............................] - ETA: 7:55 - loss: 1.8006 - model_acc: 0.3954
---------------------------------------------------------------------------
KeyboardInterrupt                         Traceback (most recent call last)
~\AppData\Local\Temp/ipykernel_20672/2602493766.py in <module>
```