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)

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)
```

```
(35393, 48, 48, 1)
(35393, 8)
(35393, 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: (31858, 48, 48, 3)
training_emotions shape: (31858, 8)
test_images shape: (3535, 48, 48, 3)
test_emotions shape: (3535, 8)
```

In [5]:

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

base_model = resnet.ResNet50(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-4),
              loss=losses.CategoricalCrossentropy(),
              metrics = [model_acc])

model.fit(x=training_images,
          y=training_emotions,
          batch_size=16,
          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.confi
g.experimental_run_functions_eagerly` option is set, this option does not apply to tf.data functions. To force eager execution of
tf.data functions, please use `tf.data.experimental.enable.debug_mode()`.
  warnings.warn(
Epoch 1/40
1992/1992 [==============================] - 286s 142ms/step - loss: 1.2452 - model_acc: 0.6448 - val_loss: 1.0296 - val_model_ac
c: 0.7335
Epoch 2/40
1992/1992 [==============================] - 284s 142ms/step - loss: 0.9965 - model_acc: 0.7699 - val_loss: 0.9702 - val_model_ac
c: 0.7680
Epoch 3/40
1992/1992 [==============================] - 282s 142ms/step - loss: 0.9022 - model_acc: 0.8175 - val_loss: 0.9608 - val_model_ac
c: 0.7705
Epoch 4/40
1992/1992 [==============================] - 284s 142ms/step - loss: 0.8403 - model_acc: 0.8499 - val_loss: 0.9473 - val_model_ac
c: 0.7844
Epoch 5/40
1992/1992 [==============================] - 285s 143ms/step - loss: 0.7923 - model_acc: 0.8747 - val_loss: 0.9353 - val_model_ac
c: 0.7816
Epoch 6/40
1992/1992 [==============================] - 283s 142ms/step - loss: 0.7581 - model_acc: 0.8942 - val_loss: 0.9401 - val_model_ac
c: 0.8022
Epoch 7/40
1992/1992 [==============================] - 283s 142ms/step - loss: 0.7274 - model_acc: 0.9060 - val_loss: 0.9547 - val_model_ac
c: 0.8008
Epoch 8/40
1992/1992 [==============================] - 283s 142ms/step - loss: 0.7061 - model_acc: 0.9148 - val_loss: 0.9595 - val_model_ac
```

```
c: 0.7972
Epoch 9/40
1992/1992 [==============================] - 282s 141ms/step - loss: 0.6856 - model_acc: 0.9186 - val_loss: 0.9455 - val_model_ac
c: 0.8034
Epoch 10/40
1992/1992 [==============================] - 283s 142ms/step - loss: 0.6650 - model_acc: 0.9250 - val_loss: 0.9791 - val_model_ac
c: 0.7977
Epoch 11/40
1992/1992 [==============================] - 283s 142ms/step - loss: 0.6521 - model_acc: 0.9286 - val_loss: 0.9849 - val_model_ac
c: 0.7999
Epoch 12/40
1992/1992 [==============================] - 283s 142ms/step - loss: 0.6362 - model_acc: 0.9334 - val_loss: 0.9717 - val_model_ac
c: 0.8051
Epoch 13/40
1992/1992 [==============================] - 281s 141ms/step - loss: 0.6248 - model_acc: 0.9361 - val_loss: 1.0216 - val_model_ac
c: 0.8045
Epoch 14/40
1992/1992 [==============================] - 281s 141ms/step - loss: 0.6164 - model_acc: 0.9389 - val_loss: 1.0016 - val_model_ac
c: 0.8031
Epoch 15/40
1992/1992 [==============================] - 282s 141ms/step - loss: 0.6065 - model_acc: 0.9434 - val_loss: 1.0354 - val_model_ac
c: 0.7980
Epoch 16/40
1992/1992 [==============================] - 280s 141ms/step - loss: 0.6031 - model_acc: 0.9428 - val_loss: 1.0396 - val_model_ac
c: 0.8011
Epoch 17/40
1992/1992 [==============================] - 281s 141ms/step - loss: 0.5992 - model_acc: 0.9450 - val_loss: 1.0395 - val_model_ac
c: 0.8073
Epoch 18/40
1992/1992 [==============================] - 282s 142ms/step - loss: 0.5917 - model_acc: 0.9480 - val_loss: 1.0723 - val_model_ac
c: 0.8062
Epoch 19/40
1992/1992 [==============================] - 282s 141ms/step - loss: 0.5929 - model_acc: 0.9514 - val_loss: 1.0987 - val_model_ac
c: 0.8037
Epoch 20/40
1992/1992 [==============================] - 280s 141ms/step - loss: 0.5824 - model_acc: 0.9522 - val_loss: 1.1133 - val_model_ac
c: 0.8008
Epoch 21/40
1992/1992 [==============================] - 281s 141ms/step - loss: 0.5838 - model_acc: 0.9548 - val_loss: 1.1698 - val_model_ac
c: 0.8042
Epoch 22/40
1992/1992 [==============================] - 281s 141ms/step - loss: 0.5806 - model_acc: 0.9549 - val_loss: 1.1558 - val_model_ac
c: 0.8062
Epoch 23/40
```

```
1992/1992 [==============================] - 280s 141ms/step - loss: 0.5783 - model_acc: 0.9571 - val_loss: 1.1308 - val_model_ac
c: 0.8054
Epoch 24/40
1992/1992 [==============================] - 281s 141ms/step - loss: 0.5805 - model_acc: 0.9543 - val_loss: 1.1089 - val_model_ac
c: 0.8057
Epoch 25/40
1992/1992 [==============================] - 282s 142ms/step - loss: 0.5718 - model_acc: 0.9601 - val_loss: 1.1676 - val_model_ac
c: 0.7977
Epoch 26/40
1992/1992 [==============================] - 281s 141ms/step - loss: 0.5757 - model_acc: 0.9585 - val_loss: 1.1670 - val_model_ac
c: 0.8020
Epoch 27/40
1992/1992 [==============================] - 282s 142ms/step - loss: 0.5773 - model_acc: 0.9570 - val_loss: 1.1739 - val_model_ac
c: 0.8031
Epoch 28/40
1992/1992 [==============================] - 281s 141ms/step - loss: 0.5669 - model_acc: 0.9637 - val_loss: 1.1982 - val_model_ac
c: 0.7999
Epoch 29/40
1992/1992 [==============================] - 275s 138ms/step - loss: 0.5693 - model_acc: 0.9612 - val_loss: 1.2147 - val_model_ac
c: 0.8019
Epoch 30/40
1992/1992 [==============================] - 277s 139ms/step - loss: 0.5697 - model_acc: 0.9609 - val_loss: 1.1565 - val_model_ac
c: 0.8099
Epoch 31/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.5666 - model_acc: 0.9634 - val_loss: 1.2682 - val_model_ac
c: 0.8064
Epoch 32/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.5689 - model_acc: 0.9629 - val_loss: 1.2142 - val_model_ac
c: 0.7992
Epoch 33/40
1992/1992 [==============================] - 272s 137ms/step - loss: 0.5638 - model_acc: 0.9640 - val_loss: 1.2238 - val_model_ac
c: 0.8065
Epoch 34/40
1992/1992 [==============================] - 272s 137ms/step - loss: 0.5653 - model_acc: 0.9660 - val_loss: 1.2001 - val_model_ac
c: 0.8054
Epoch 35/40
1992/1992 [==============================] - 271s 136ms/step - loss: 0.5659 - model_acc: 0.9641 - val_loss: 1.2034 - val_model_ac
c: 0.8031
Epoch 36/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.5641 - model_acc: 0.9645 - val_loss: 1.2020 - val_model_ac
c: 0.8085
Epoch 37/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.5586 - model_acc: 0.9707 - val_loss: 1.2546 - val_model_ac
c: 0.8071
```

```
Epoch 38/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.5648 - model_acc: 0.9651 - val_loss: 1.2793 - val_model_ac
c: 0.8062
Epoch 39/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.5606 - model_acc: 0.9688 - val_loss: 1.3194 - val_model_ac
c: 0.7940
Epoch 40/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.5628 - model_acc: 0.9668 - val_loss: 1.2689 - val_model_ac
c: 0.7980
```

Out[5]: <tensorflow.python.keras.callbacks.History at 0x19400aae5e0>

In [6]:

```
base_model = resnet.ResNet50(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-4),
              loss=losses.CategoricalCrossentropy(),
              metrics = [model_acc])

model.fit(x=training_images,
          y=training_emotions,
          batch_size=16,
          epochs=40,
          validation_data=(test_images, test_emotions))
```

```
Epoch 1/40
1992/1992 [==============================] - 273s 137ms/step - loss: 1.2357 - model_acc: 0.6538 - val_loss: 1.0544 - val_model_ac
c: 0.7213
Epoch 2/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.9955 - model_acc: 0.7683 - val_loss: 0.9796 - val_model_ac
c: 0.7711
Epoch 3/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.9004 - model_acc: 0.8165 - val_loss: 0.9702 - val_model_ac
c: 0.7692
Epoch 4/40
```

```
1992/1992 [==============================] - 274s 137ms/step - loss: 0.8383 - model_acc: 0.8493 - val_loss: 0.9483 - val_model_ac
c: 0.7859
Epoch 5/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.7964 - model_acc: 0.8737 - val_loss: 0.9403 - val_model_ac
c: 0.7841
Epoch 6/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.7540 - model_acc: 0.8938 - val_loss: 0.9443 - val_model_ac
c: 0.7931
Epoch 7/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.7288 - model_acc: 0.9055 - val_loss: 0.9491 - val_model_ac
c: 0.8017
Epoch 8/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.7055 - model_acc: 0.9145 - val_loss: 0.9521 - val_model_ac
c: 0.7963
Epoch 9/40
1992/1992 [==============================] - 274s 138ms/step - loss: 0.6839 - model_acc: 0.9189 - val_loss: 0.9471 - val_model_ac
c: 0.7997
Epoch 10/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.6678 - model_acc: 0.9232 - val_loss: 0.9586 - val_model_ac
c: 0.8020
Epoch 11/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.6527 - model_acc: 0.9286 - val_loss: 0.9623 - val_model_ac
c: 0.8042
Epoch 12/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.6403 - model_acc: 0.9314 - val_loss: 0.9854 - val_model_ac
c: 0.8077
Epoch 13/40
1992/1992 [==============================] - 274s 138ms/step - loss: 0.6236 - model_acc: 0.9373 - val_loss: 1.0055 - val_model_ac
c: 0.7960
Epoch 14/40
1992/1992 [==============================] - 274s 138ms/step - loss: 0.6152 - model_acc: 0.9376 - val_loss: 1.0370 - val_model_ac
c: 0.7918
Epoch 15/40
1992/1992 [==============================] - 275s 138ms/step - loss: 0.6110 - model_acc: 0.9404 - val_loss: 1.0553 - val_model_ac
c: 0.8005
Epoch 16/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.6025 - model_acc: 0.9443 - val_loss: 1.0525 - val_model_ac
c: 0.7940
Epoch 17/40
1992/1992 [==============================] - 274s 138ms/step - loss: 0.5963 - model_acc: 0.9484 - val_loss: 1.0699 - val_model_ac
c: 0.8099
Epoch 18/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.5918 - model_acc: 0.9496 - val_loss: 1.0875 - val_model_ac
c: 0.8062
```

```
Epoch 19/40
1992/1992 [==============================] - 275s 138ms/step - loss: 0.5904 - model_acc: 0.9479 - val_loss: 1.0986 - val_model_ac
c: 0.8079
Epoch 20/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.5799 - model_acc: 0.9543 - val_loss: 1.1208 - val_model_ac
c: 0.8014
Epoch 21/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.5843 - model_acc: 0.9533 - val_loss: 1.1343 - val_model_ac
c: 0.8031
Epoch 22/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.5792 - model_acc: 0.9552 - val_loss: 1.1534 - val_model_ac
c: 0.8093
Epoch 23/40
1992/1992 [==============================] - 274s 138ms/step - loss: 0.5784 - model_acc: 0.9543 - val_loss: 1.1882 - val_model_ac
c: 0.7940
Epoch 24/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.5786 - model_acc: 0.9571 - val_loss: 1.1789 - val_model_ac
c: 0.7982
Epoch 25/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.5756 - model_acc: 0.9583 - val_loss: 1.2330 - val_model_ac
c: 0.7986
Epoch 26/40
1992/1992 [==============================] - 275s 138ms/step - loss: 0.5750 - model_acc: 0.9573 - val_loss: 1.1953 - val_model_ac
c: 0.8099
Epoch 27/40
1992/1992 [==============================] - 274s 138ms/step - loss: 0.5703 - model_acc: 0.9616 - val_loss: 1.2075 - val_model_ac
c: 0.8048
Epoch 28/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.5770 - model_acc: 0.9585 - val_loss: 1.1797 - val_model_ac
c: 0.8053
Epoch 29/40
1992/1992 [==============================] - 275s 138ms/step - loss: 0.5704 - model_acc: 0.9616 - val_loss: 1.2266 - val_model_ac
c: 0.8056
Epoch 30/40
1992/1992 [==============================] - 275s 138ms/step - loss: 0.5640 - model_acc: 0.9649 - val_loss: 1.2910 - val_model_ac
c: 0.7972
Epoch 31/40
1992/1992 [==============================] - 274s 138ms/step - loss: 0.5690 - model_acc: 0.9616 - val_loss: 1.2075 - val_model_ac
c: 0.8107
Epoch 32/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.5702 - model_acc: 0.9613 - val_loss: 1.2403 - val_model_ac
c: 0.8130
Epoch 33/40
1992/1992 [==============================] - 275s 138ms/step - loss: 0.5632 - model_acc: 0.9664 - val_loss: 1.2406 - val_model_ac
```

```
c: 0.8036
Epoch 34/40
1992/1992 [==============================] - 274s 138ms/step - loss: 0.5679 - model_acc: 0.9606 - val_loss: 1.2635 - val_model_ac
c: 0.8090
Epoch 35/40
1992/1992 [==============================] - 274s 138ms/step - loss: 0.5639 - model_acc: 0.9646 - val_loss: 1.3582 - val_model_ac
c: 0.7972
Epoch 36/40
1992/1992 [==============================] - 273s 137ms/step - loss: 0.5672 - model_acc: 0.9644 - val_loss: 1.2285 - val_model_ac
c: 0.8076
Epoch 37/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.5608 - model_acc: 0.9691 - val_loss: 1.2517 - val_model_ac
c: 0.8045
Epoch 38/40
1992/1992 [==============================] - 274s 137ms/step - loss: 0.5669 - model_acc: 0.9644 - val_loss: 1.2878 - val_model_ac
c: 0.7937
Epoch 39/40
1992/1992 [==============================] - 276s 138ms/step - loss: 0.5609 - model_acc: 0.9678 - val_loss: 1.2840 - val_model_ac
c: 0.7992
Epoch 40/40
1992/1992 [==============================] - 275s 138ms/step - loss: 0.5598 - model_acc: 0.9688 - val_loss: 1.3109 - val_model_ac
c: 0.8011
```

Out[6]: `<tensorflow.python.keras.callbacks.History at 0x196652dc7f0>`

In [ ]: