學號：R08246009 系級： 應數碩二 姓名：許哲維

1. (1%) 請說明這次使用的model架構，包含各層維度及連接方式。

   連接方式，以及各層的維度如下圖所示

```
        # input 維度 [3, 48, 48]
        self.cnn = nn.Sequential(
                nn.Conv2d(3, 24, 3, 1, 1), # [24, 48, 48]
                nn.BatchNorm2d(24),
                nn.ReLU(),
                nn.MaxPool2d(2, 2, 0),        # [24, 24, 24]

                nn.Conv2d(24, 48, 3, 1, 1), # [48, 24, 24]
                nn.BatchNorm2d(48),
                nn.ReLU(),
                nn.MaxPool2d(2, 2, 0),           # [48, 12, 12]

                nn.Conv2d(48, 96, 3, 1, 1), # [96, 12, 12]
                nn.BatchNorm2d(96),
                nn.ReLU(),
                nn.MaxPool2d(2, 2, 0),           # [96, 6, 6]

                nn.Conv2d(96, 96, 3, 1, 1), # [192, 6, 6]
                nn.BatchNorm2d(96),
                nn.ReLU(),
                nn.MaxPool2d(2, 2, 0),             # [192, 3, 3]
        )
        self.fc = nn.Sequential(
                nn.Linear(96*3*3, 192),
                nn.ReLU(),
                nn.Linear(192, 96),
                nn.ReLU(),
                nn.Linear(96, 7)
```

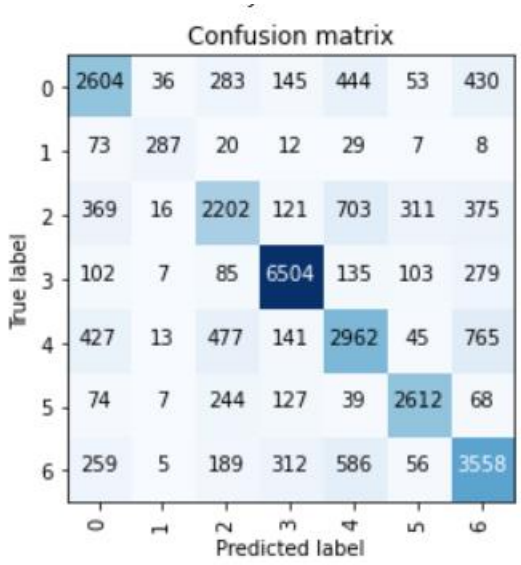
2. (1%) 請附上model的training/validation history (loss and accuracy)。

   總共 iterate 30次：

```
[001/030] 10.11 sec(s) Train Acc: 0.392968 Loss: 0.032135 | Val Acc: 0.464057 loss: 0.029018
[002/030] 9.67 sec(s) Train Acc: 0.482653 Loss: 0.027770 | Val Acc: 0.450961 loss: 0.029405
[003/030] 9.60 sec(s) Train Acc: 0.516883 Loss: 0.026222 | Val Acc: 0.496239 loss: 0.027264
[004/030] 9.72 sec(s) Train Acc: 0.540151 Loss: 0.024988 | Val Acc: 0.551268 loss: 0.024792
[005/030] 9.64 sec(s) Train Acc: 0.555989 Loss: 0.024304 | Val Acc: 0.551407 loss: 0.024939
[006/030] 9.81 sec(s) Train Acc: 0.567322 Loss: 0.023645 | Val Acc: 0.549317 loss: 0.024361
[007/030] 10.00 sec(s) Train Acc: 0.581394 Loss: 0.022835 | Val Acc: 0.556144 loss: 0.023954
[008/030] 9.68 sec(s) Train Acc: 0.594863 Loss: 0.022410 | Val Acc: 0.551964 loss: 0.024587
[009/030] 9.69 sec(s) Train Acc: 0.598625 Loss: 0.022087 | Val Acc: 0.577598 loss: 0.023306
[010/030] 9.72 sec(s) Train Acc: 0.610469 Loss: 0.021436 | Val Acc: 0.573837 loss: 0.023584
[011/030] 9.70 sec(s) Train Acc: 0.616274 Loss: 0.021084 | Val Acc: 0.567150 loss: 0.023932
[012/030] 9.55 sec(s) Train Acc: 0.622498 Loss: 0.020778 | Val Acc: 0.590554 loss: 0.022548
[013/030] 9.73 sec(s) Train Acc: 0.633227 Loss: 0.020316 | Val Acc: 0.582335 loss: 0.023662
[014/030] 9.60 sec(s) Train Acc: 0.635456 Loss: 0.019987 | Val Acc: 0.586654 loss: 0.023380
[015/030] 9.71 sec(s) Train Acc: 0.645256 Loss: 0.019611 | Val Acc: 0.581778 loss: 0.023460
[016/030] 10.01 sec(s) Train Acc: 0.653337 Loss: 0.019175 | Val Acc: 0.578016 loss: 0.023764
[017/030] 9.65 sec(s) Train Acc: 0.655195 Loss: 0.019037 | Val Acc: 0.595848 loss: 0.022768
[018/030] 9.72 sec(s) Train Acc: 0.662626 Loss: 0.018624 | Val Acc: 0.598217 loss: 0.022441
[019/030] 9.83 sec(s) Train Acc: 0.666574 Loss: 0.018536 | Val Acc: 0.599889 loss: 0.022307
[020/030] 9.90 sec(s) Train Acc: 0.675445 Loss: 0.018101 | Val Acc: 0.604068 loss: 0.022718
[021/030] 9.94 sec(s) Train Acc: 0.677906 Loss: 0.017848 | Val Acc: 0.609501 loss: 0.022650
[022/030] 9.65 sec(s) Train Acc: 0.688681 Loss: 0.017393 | Val Acc: 0.596824 loss: 0.023450
[023/030] 9.73 sec(s) Train Acc: 0.688031 Loss: 0.017290 | Val Acc: 0.606436 loss: 0.023601
[024/030] 9.63 sec(s) Train Acc: 0.694441 Loss: 0.016970 | Val Acc: 0.600724 loss: 0.023641
[025/030] 9.79 sec(s) Train Acc: 0.700014 Loss: 0.016672 | Val Acc: 0.606715 loss: 0.023208
[026/030] 9.62 sec(s) Train Acc: 0.700246 Loss: 0.016636 | Val Acc: 0.594595 loss: 0.023339
[027/030] 9.86 sec(s) Train Acc: 0.705448 Loss: 0.016387 | Val Acc: 0.576484 loss: 0.025550
[028/030] 9.64 sec(s) Train Acc: 0.711997 Loss: 0.016103 | Val Acc: 0.597381 loss: 0.023899
[029/030] 10.09 sec(s) Train Acc: 0.713901 Loss: 0.015886 | Val Acc: 0.556980 loss: 0.025458
[030/030] 9.86 sec(s) Train Acc: 0.718545 Loss: 0.015747 | Val Acc: 0.600446 loss: 0.023223
```

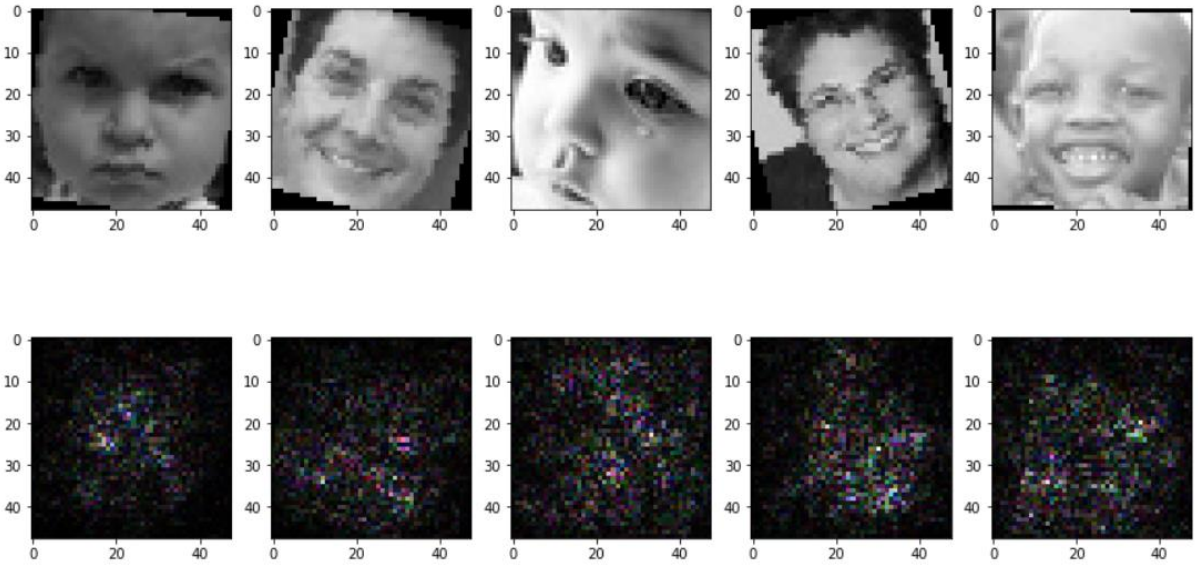
3. (1%) 畫出confusion matrix分析哪些類別的圖片容易使model搞混，並簡單說明。

   下圖的confusion matrix是透過 full data (沒有切validation set)，所train出來的model對training set去做分類模型所得到的matrix。我們可以看到第三類分的最好，而第2類以及第4類分的最差。第2類的圖片跟第4類的圖片容易搞混，如果是對回到人的情緒的話是fear跟sad不容易分出來。



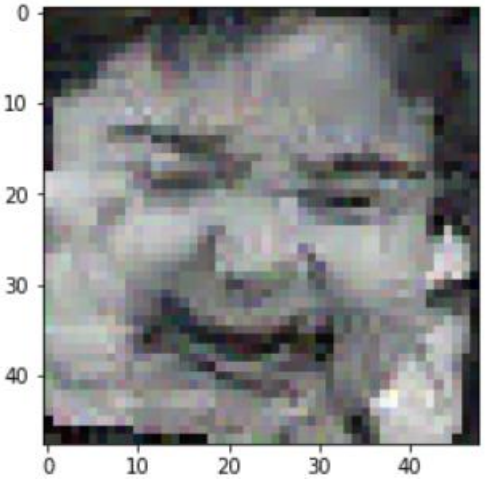
4. (1%) 畫出CNN model的saliency map，並簡單討論其現象。

   我隨機選了5張圖來呈現，會發現下排影像中，亮點的部分會是cnn感興趣的部分，但好像沒辦法用肉眼做出太大區隔。



5. (1%) 畫出最後一層的filters最容易被哪些feature activate。

   劃出最後一層的第 0 個 filter 會發現他好像在任一些線條的感覺。



6. (3%)Refer to math problem

r08246009

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HW3.

1.

l: loss function.

$$\frac{\partial l}{\partial \hat{x}_i} = \frac{\partial l}{\partial y_i} \cdot \gamma \quad \#.$$

$$\frac{\partial l}{\partial \sigma_B^2} = \sum_{i=1}^{m} \frac{\partial l}{\partial y_i} \frac{\partial y_i}{\partial \hat{x}_i} \frac{\partial \hat{x}_i}{\partial \sigma_B^2}$$

$$= \sum_{i=1}^{m} \frac{\partial l}{\partial y_i} \gamma \left(-\frac{1}{2}\right) (x_i - \mu_B)(\sigma_B^2 + \varepsilon)^{-\frac{3}{2}} \quad \#.$$

$$\frac{\partial l}{\partial \mu_B} = \sum_{i=1}^{m} \frac{\partial l}{\partial y_i} \frac{\partial y_i}{\partial \hat{x}_i} \frac{\partial \hat{x}_i}{\partial \mu_B}$$

$$= \sum_{i=1}^{m} \frac{\partial l}{\partial y_i} \gamma \frac{-(\sigma_B^2 + \varepsilon)^{\frac{1}{2}} + (x_i - \mu_B) \frac{1}{2} (\sigma_B^2 + \varepsilon)^{-\frac{1}{2}} \frac{2}{m} \sum_{i=1}^{m} (x_i - \mu_B)}{\sigma_B^2 + \varepsilon}.$$

$$= \sum_{i=1}^{m} \frac{\partial l}{\partial y_i} \gamma \left[\left(\frac{-1}{(\sigma_B^2 + \varepsilon)^{\frac{1}{2}}} \right) + \frac{-(x_i - \mu_B)}{2} (\sigma_B^2 + \varepsilon)^{-\frac{3}{2}} \frac{-2}{m} \sum_{i=1}^{m} (x_i - \mu_B) \right] \quad \#.$$

$$\frac{\partial l}{\partial x_i} = \frac{\partial l}{\partial y_i} \frac{\partial y_i}{\partial \hat{x}_i} \frac{\partial \hat{x}_i}{\partial x_i}$$

$$= \frac{\partial l}{\partial \hat{x}_i} \frac{1}{\sqrt{\sigma_B^2 + \varepsilon}} + \frac{\partial l}{\partial \mu_B} \cdot \frac{1}{m} + \frac{\partial l}{\partial \sigma_B^2} \frac{2}{m} (x_i - \mu_B) \quad \#.$$

$$\frac{\partial l}{\partial \gamma} = \sum_{i=1}^{m} \frac{\partial l}{\partial y_i} \hat{x}_i \quad \#.$$

$$\frac{\partial l}{\partial \beta} = \sum_{i=1}^{m} \frac{\partial l}{\partial y_i} \quad \#$$

No.

Date

2.

Consider

$$\frac{\partial L}{\partial z_t} = \frac{-\partial \sum_i y_i \log(\hat{y}_i)}{\partial z_t} = -\sum_i y_i \frac{1}{\hat{y}_i} \frac{\partial \hat{y}_i}{\partial z_t}$$

$$= -\frac{y_t}{\hat{y}_t} \frac{\partial \hat{y}_t}{\partial z_t} + \sum_{i \neq t} \frac{-y_i}{\hat{y}_i} \frac{\partial \hat{y}_i}{\partial z_t}$$

$$= \frac{-y_t}{\hat{y}_t} \hat{y}_t(1-\hat{y}_t) + \sum_{i \neq t} \frac{-y_i}{\hat{y}_i} (-\hat{y}_i \hat{y}_t).$$

$$= -y_t(1-\hat{y}_t) + \sum_{i \neq t} y_i \hat{y}_t$$

$$= -y_t + y_t \hat{y}_t + \hat{y}_t \sum_{i \neq t} y_i = -y_t + \hat{y}_t \sum_i y_i = \hat{y}_t - y_t \quad \#.$$