Homework3 Report

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EE5184 - Machine Learning

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1. (1%) 請說明你實作的 CNN model，其模型架構、訓練過程和準確率為何？

架構如右圖，基本上只是基本的CNN以及Flattern之後接上Dense，並且在每一層之間加上Norm_Batch以及Dropout。

共四次 Cov2d Maxpool 之組合
Flattern後兩層Dense
最後接Softmax

訓練過程使用Adam訓練61個epoch
並使用ImageDataGenerator增加更多影像訓練
參數為 rotation_range=15,
width_shift_range=0.1,
height_shift_range=0.1

準確率public score為0.68041

其實這模型由於有不少隨機的因素，所以訓練完準確率會在0.65~0.68之間，我是嘗試多次之後找一次最高的繳交。

Layer (type)	Output Shape	Param #
conv2d_5 (Conv2D)	(None, 48, 48, 128)	1280
batch_normalization_11 (Batc	(None, 48, 48, 128)	512
dropout_11 (Dropout)	(None, 48, 48, 128)	0
max_pooling2d_5 (MaxPooling2	(None, 24, 24, 128)	0
batch_normalization_12 (Batc	(None, 24, 24, 128)	512
dropout_12 (Dropout)	(None, 24, 24, 128)	0
conv2d_6 (Conv2D)	(None, 24, 24, 256)	295168
batch_normalization_13 (Batc	(None, 24, 24, 256)	1024
dropout_13 (Dropout)	(None, 24, 24, 256)	0
max_pooling2d_6 (MaxPooling2	(None, 12, 12, 256)	0
batch_normalization_14 (Batc	(None, 12, 12, 256)	1024
dropout_14 (Dropout)	(None, 12, 12, 256)	0
conv2d_7 (Conv2D)	(None, 12, 12, 512)	1180160
batch_normalization_15 (Batc	(None, 12, 12, 512)	2048
dropout_15 (Dropout)	(None, 12, 12, 512)	0
max_pooling2d_7 (MaxPooling2	(None, 6, 6, 512)	0
batch_normalization_16 (Batc	(None, 6, 6, 512)	2048
dropout_16 (Dropout)	(None, 6, 6, 512)	0
conv2d_8 (Conv2D)	(None, 6, 6, 512)	2359808
batch_normalization_17 (Batc	(None, 6, 6, 512)	2048
dropout_17 (Dropout)	(None, 6, 6, 512)	0
max_pooling2d_8 (MaxPooling2	(None, 3, 3, 512)	0
batch_normalization_18 (Batc	(None, 3, 3, 512)	2048
dropout_18 (Dropout)	(None, 3, 3, 512)	0
flatten_2 (Flatten)	(None, 4608)	0
dense_3 (Dense)	(None, 512)	2359808
batch_normalization_19 (Batc	(None, 512)	2048
dropout_19 (Dropout)	(None, 512)	0
dense_4 (Dense)	(None, 512)	262656
batch_normalization_20 (Batc	(None, 512)	2048
dropout_20 (Dropout)	(None, 512)	0
dense_5 (Dense)	(None, 7)	3591

Total params: 6,477,831
Trainable params: 6,470,151

2. (1%) 承上題，請用與上述 CNN 接近的參數量，實做簡單的 DNN model，其模型架構、訓練過程和準確率為何？試與上題結果做比較，並說明你觀察到了什麼？

DNN參數量：
Total params: 6,302,855
Trainable params: 6,292,103

模型架構跟上面模型基本一樣，只是把所有Cov2d Maxpool組合換成Dense
訓練過程同樣使用Adam訓練61個epoch，準確率public score為0.37280，相對於CNN模型準確率只有一半以下。

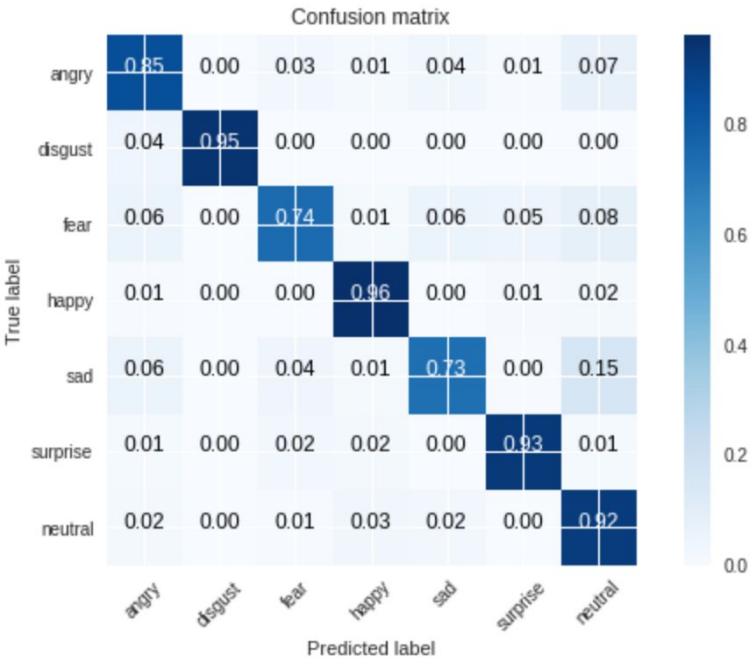
原因可能是DNN模型並不會考慮2d空間點跟點之間的相關性，所以效果較差，而且更容易overfitting。

3. (1%) 觀察答錯的圖片中，哪些 class 彼此間容易用混？ 並說明你觀察到了什麼？ [繪出 confusion matrix 分析]

如右圖，可以發現幾個比較容易混淆的
實際為生氣、預測為中立(0.07)
實際為恐懼、預測為生氣(0.06)
實際為恐懼、預測為難過(0.06)
實際為恐懼、預測為中立(0.08)
實際為難過、預測為生氣(0.06)
實際為難過、預測為中立(0.15)

看起來恐懼、難過、生氣等負面情緒都比較容易與其他負面情緒或中立混淆

尤其是難過，容易被判斷為中立



----------Handwritten question----------

4. (1.5%,each 0.5%)CNN time/space complexity:

For a. b. Given a CNN model as

```
model = Sequential()
model.add(Conv2D(filters=6,
                 strides=(3, 3),
"""Layer A"""    padding ="valid",
                 kernel_size=(2,2),
                 input_shape=(8,8,5),
                 activation='relu'))
model.add(Conv2D(filters=4,
                 strides=(2, 2),
"""Layer B"""    padding ="valid",
                 kernel_size=(2,2),
                 activation='relu'))
```

And for the c. given the parameter as:

kernel size = (k,k);

channel size = c;

filter size = f;

input shape = (n,n);

padding = 1;

strides = (s,s);

a. How many parameters are there in each layer(Hint: you may consider whether the number of parameter is related with)

Layer A:

Layer B:

b. How many multiplications/additions are needed for a forward pass(each layer).
   Layer A:
   Layer B:
c. What is the time complexity of convolutional neural networks?(note: you must use big-O upper bound, and there are l layer, you can use C_l, C_{l-1} as lth and l-1th layer)

5. (1.5%,each 0.5%)PCA practice:Problem statement: Given 10 samples in 3D space.(1,2,3),(4,8,5),(3,12,9),(1,8,5),(5,14,2),(7,4,1),(9,8,9),(3,8,1),(11,5,6),(10,11,7)
   a. (1) What are the principal axes?
   b. (2) Compute the principal components for each sample.
   c. (3) Reconstruction error if reduced to 2D.(Calculate the L2-norm)