Homework3 Report Template

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EE5184 - Machine Learning
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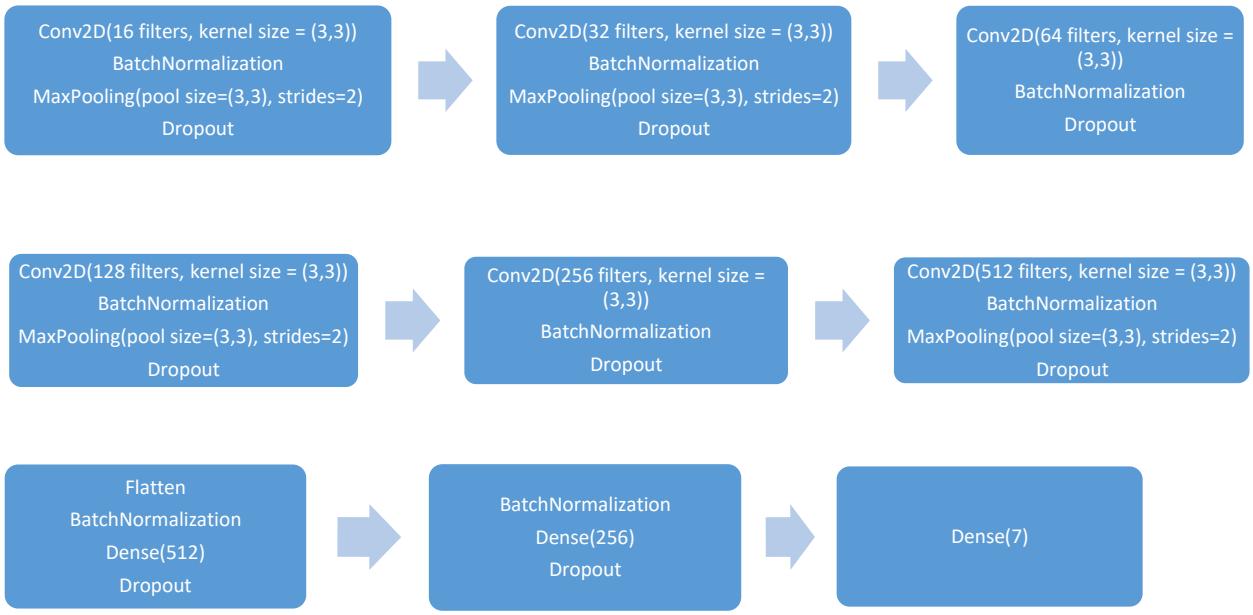
Note:1~3 題建議不要超過三頁

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？
模型架構:



主要是以 6 層 Conv 和 3 層 Dense 組成，6 層 Conv 分別有 16, 32, 64, 128, 236, 512 個 filter；Dense 則分別有 512，256 個維度，最後利用 softmax 壓到 7 維。我用 batch size 等於 150，epoch = 300 來 train，這樣達到的準確度大約是:public 0.64363 private0.65032。後來也有再加上 ImageDataGenerator 和 Ensemble，就能過 strong baseline 了。

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？

我以(由前到後)units=128, 256, 1024, 2048, 7 的 Dense 來架構 DNN。當然中間都有隔著 BatchNormalization Layer 和 Dropout Layer。Epoch = 300, batch size = 150(同第一題的 CNN)

CNN 參數: 2,768,967

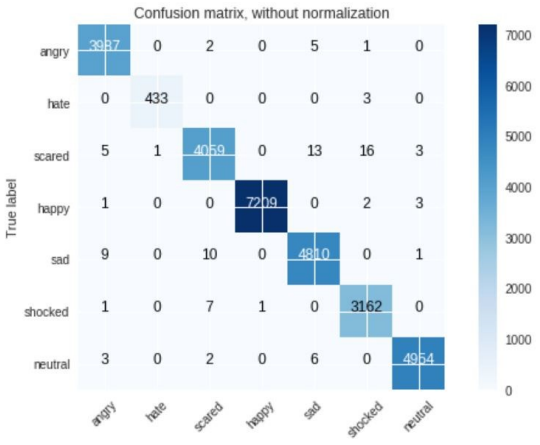
CNN 準確率 public 0.64363 private0.65032

我建的 DNN 參數:2,718,599

DNN 準確率 public 0.36054 private0.36333

由上面的數據看出，DNN 很明顯的表現不如 CNN，訓練時 accuracy 也爬升的極慢。因此，訓練與 image 有關的 model 時，CNN 常常都還是較佳的選擇。

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]



[Confusion matrix]

觀察 confusion matrix 我發覺 hate 占整體資料量最少，最多的則是 happy。

至於容易搞混的類別，大約有以下幾種(<True--Predicted>)(照容易搞混的程度由大到小排序):

<scared--shocked>, <scared—sad>, <sad--scared>, <sad--angry>, <shocked--scared>, <neutral--sad>

我發覺驚嚇和恐懼、驚嚇和悲傷最容易被搞混，其實蠻合理的，因為這幾者可能都有瞪大眼睛、張大嘴巴等等的類似面部動作；而快樂最不容易和其他的類別搞混。

----------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;

input shape = (n,n);

padding = p;

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:

(5 * 2 * 2 + 1)*6 = 126

Layer B:

(6 * 2 * 2 + 1)*4 = 100

b. How many multiplications/additions are needed for a forward pass(each layer).

Layer A:

<input: 8*8*5>

multiplication:6 * (2*2*5*9)=1080

addition:6 * (2*2*5-1)*9 = 1026

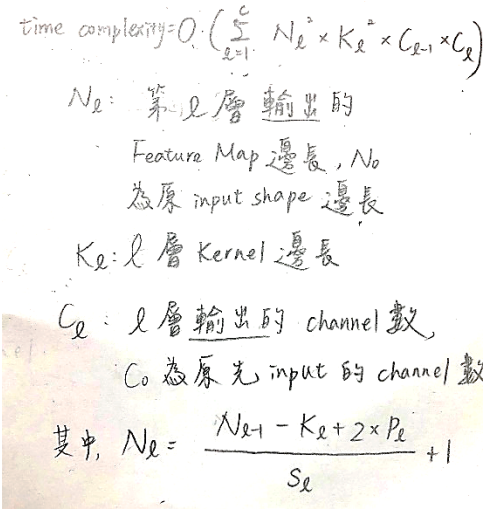
Layer B:

<input: 3*3*6>

multiplication:4 * (2*2*6*1) = 96

addition:4 * (2*2*6-1)*1 = 92

c. What is the time complexity of convolutional neural networks?(note: you must use big-O upper bound, and there are l(lower case of L) layer, you can use Cl,Cl-1as 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?

平均值 = (5.4,8,4.8)

減去平均值後 =(-4.4,-6,-1.8),(-1.4,0, 0.2),(-2.4,4,4.2),(-4.4,0,0.2),(-0.4,6 ,-2.8),(1.6,-4,-3.8),(3.6,0,4.2), (-2.4,0,-3.8),(5.6,-3,1.2),(4.6,3,2.2)

Cov = $\begin{pmatrix} 120.4 & 5 & 32.8 \\ 5 & 122 & 29 \\ 32.8 & 29 & 81.6 \end{pmatrix}$

Eigenvalues = 54.72, 116.305, 152.974

Principle axes = Eigenvectors = (0.39985541, 0.33758926, -0.85214385), (-0.67817891, 0.73439013, -0.02728563), (-0.6165947 , -0.58881629, -0.52259579)

b. (2) Compute the principal components for each sample.

將原本的 data 與 eigenvectors 所形成的矩陣

```
([[ 0.39985541, -0.67817891, -0.6165947 ],
  [ 0.33758926,  0.73439013, -0.58881629],
  [-0.85214385, -0.02728563, -0.52259579]])
```

內積，可得:

```
[[ -1.48139761,   0.70874446,  -3.36201464],
 [  0.03941652,   3.02597728,  -9.78988804],
 [ -2.41865723,   6.53257419, -13.61894165],
 [ -1.16014972,   5.06051399,  -7.94010395],
```

```
[  5.02123906,   6.83599606, -12.37159312],
[  3.29720109,  -1.83697744,  -7.19402383],
[ -1.36988181,  -0.47405978, -14.96324467],
[  3.0481365 ,   3.81329871,  -7.0829102 ],
[  0.97349277,  -3.95173109, -12.86219784],
[  1.74702909,   1.10550298, -16.30109667]] (3)
```

Reconstruction error if reduced to 2D.(Calculate the L2-norm)

將 3d 投影到 2d 的矩陣為

P = [[-0.67817891 -0.6165947]
[0.73439013 -0.58881629]
[-0.02728563 -0.52259579]]

資料被投影到 2d 後：

[[-1.37323947 7.18658682]
[0.94399334 0.75871342]
[4.45059025 -3.07034019]
[2.97853006 2.60849751]
[4.75401212 -1.82299166]
[-3.91896138 3.35457763]
[-2.55604371 -4.41464321]
[1.73131477 3.46569126]
[-6.03371503 -2.31359638]
[-0.97648096 -5.75249521]]

再乘上 P^T 還原回 3d：

[[-3.49990928 -5.24007291 -3.71821029]
[-1.10801504 0.24651657 -0.42225789]
[-1.12514095 5.07633588 1.48310968]
[-3.62836199 0.65147726 -1.44446088]
[-2.10002375 4.56470677 0.82297154]
[0.58934216 -4.85327652 -1.6461568]
[4.45550052 0.72228056 2.37681721]
[-3.31106801 -0.76919499 -1.85839567]
[5.51848951 -3.06881754 1.37370944]
[4.20918683 2.6700449   3.03287366]]

和原本的資料計算 L2-norm，10 筆資料對應的 reconstruction error：

[2.25104047 0.73022635 3.1883001 1.92979259 4.25159619 2.52755823
 2.13952468 2.27849363 0.2038499 0.97738622]

10 個 reconstruction error 的總和

20.477768358501798