National Tsing Hua University
Fall 2023 11210IPT 553000
Deep Learning in Biomedical Optical Imaging
Homework 2

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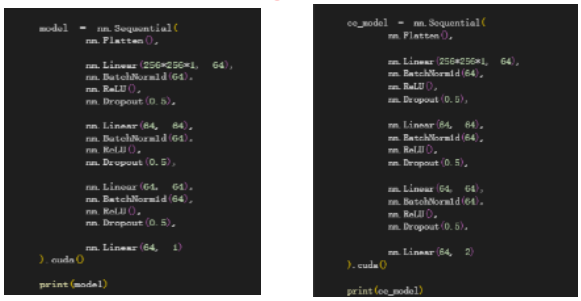
1. Task A: Performance between BCE loss and BC loss (20 pts)

Compare and analyze the model's performance such as loss and accuracy in both training and testing phases when applying Binary Cross-Entropy (BCE) loss and Cross-Entropy (CE) loss. To ensure a fair comparison, maintain the same deep learning architecture and hyperparameters.

- **training phases BCE V.S. CE** (training 以及 test 時皆使用三層的 model)



```
model = nn.Sequential(
        nn.Flatten(),

        nn.Linear(256*256*1, 64),
        nn.BatchNorm1d(64),
        nn.ReLU(),
        nn.Dropout(0.5),

        nn.Linear(64, 64),
        nn.BatchNorm1d(64),
        nn.ReLU(),
        nn.Dropout(0.5),

        nn.Linear(64, 64),
        nn.BatchNorm1d(64),
        nn.ReLU(),
        nn.Dropout(0.5),

        nn.Linear(64, 1)
).cuda()

print(model)
```

```
ce_model = nn.Sequential(
        nn.Flatten(),

        nn.Linear(256*256*1, 64),
        nn.BatchNorm1d(64),
        nn.ReLU(),
        nn.Dropout(0.5),

        nn.Linear(64, 64),
        nn.BatchNorm1d(64),
        nn.ReLU(),
        nn.Dropout(0.5),

        nn.Linear(64, 2)
).cuda()

print(ce_model)
```

Fig. 1 three layer model (左 BCE model、右 CE model)

- BCE

於 training 的時候使用 BCE 後，其 accuracy 以及 loss 如下(進行 30 個 epoch)

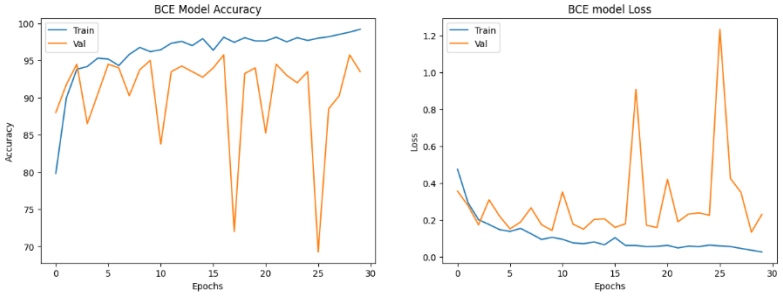


Fig. 2 BCE accuracy and loss

- CE

於 training 的時候使用 CE 後，其 accuracy 以及 loss 如下(進行 30 個 epoch)

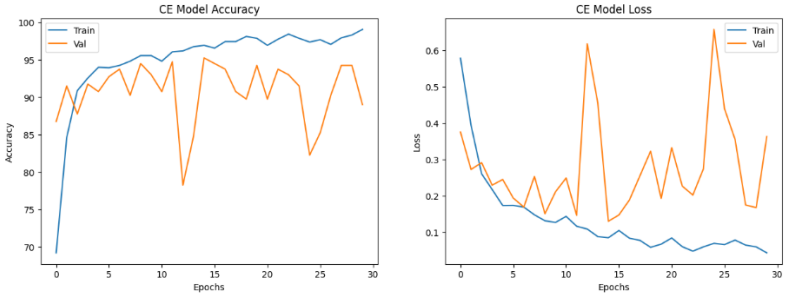


Fig. 3 CE accuracy and loss

Q1(train)總結: BCE 和 CE 兩者用來 training 後的 loss 和 accuracy 基本上差不多，震盪都很大，只不過整體看下來，CE 整體的 loss 較低，不像使用 BCE 時的 accuracy 降低的那麼多。

➢ **testing phases BCE V.S. CE**

- **BCE**

測試時，我一次測試 100 個 test data 後，約為 100 筆資料答對 47 個，**正確率為 47%。**

(num 為 0-99)

```
Num 98 Take # 210 as test image.
  This model is 51.0% confident that the scan is abnormal and 49.0% confident that the scan is normal.
  Prediction is abnormal.
  Incorrect 😡
Num 99 Take # 160 as test image.
  This model is 73.08% confident that the scan is abnormal and 26.92% confident that the scan is normal.
  Prediction is abnormal.
  Correct 😊
答對 47 個
```

Fig. 4 BCE testing accuracy result

- **CE**

測試時，我一次測試 100 個 test data 後，約為 100 筆資料答對 75 個，**正確率為 75%。**

(num 為 0-99)

```
Num 98 Take # 346 as a test image.
This ce_model is 0.68% confident that the scan is normal.
This ce_model is 99.32% confident that the scan is abnormal.
Prediction is abnormal.
Actual class is normal.
Incorrect 😡

Num 99 Take # 372 as a test image.
This ce_model is 2.11% confident that the scan is normal.
This ce_model is 97.89% confident that the scan is abnormal.
Prediction is abnormal.
Actual class is normal.
Incorrect 😡

答對 75 個
```

Fig. 5 CE testing accuracy result

Q1(test)總結: 進行 test data 測試 100 個 data 後，整體來說用 CE 弄出來的 model 最終預測正確率較高，不過兩者的正確率都不高，所以實際上其 variance 很大，有可能在 training 的時候不小心 overfitting training data 了。

2. Task B: Performance between Different Hyperparameters (40 pts)

Choose two hyperparameters and experiment with three distinct values for each. Train and test your experiment with the provided chest X-ray dataset. You need to indicate what hyperparameters you choose and which values you use in your report

➢ **changing epoch**

我使用原本的 BCE model(3 layer)並改變其 training 時的 epoch 分別為 10、30、100，而 test 的時候則用 100 個 data 測試並統計最後預測正確的數量。其餘參數皆相同不改變。

- 10 epoch

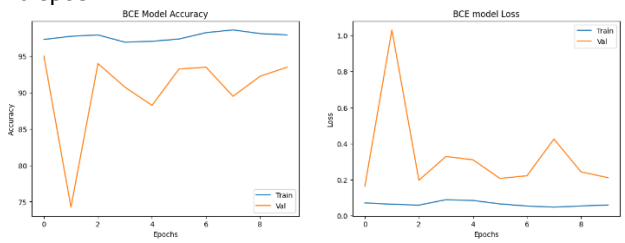


Fig. 5 10 epoch training accuracy & Loss

```
Num 99 Take # 47 as test image.
  This model is 73.09% confident that the scan is abnormal
  Prediction is abnormal.
  Correct 😊
答對 49 個
```

Fig. 6 10 epoch accuracy result (49%正確率)

- 30 epoch

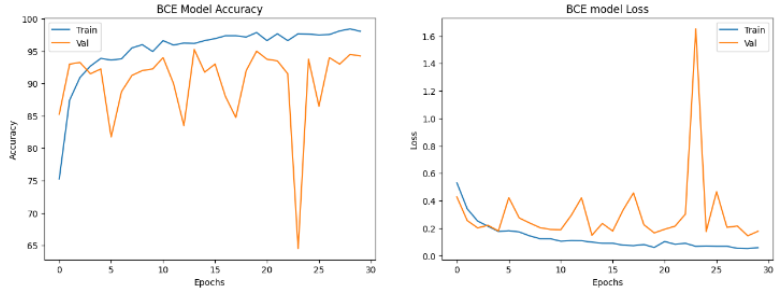


Fig. 7, 30 epoch training accuracy & Loss

```
Num 99 Take # 349 as test image.
  This model is 73.02% confident that the scan is abnormal
  Prediction is abnormal.
  Incorrect 😳
答對 56 個
```

Fig. 8　30 epoch accuracy result (56%正確率)

- 100 epoch

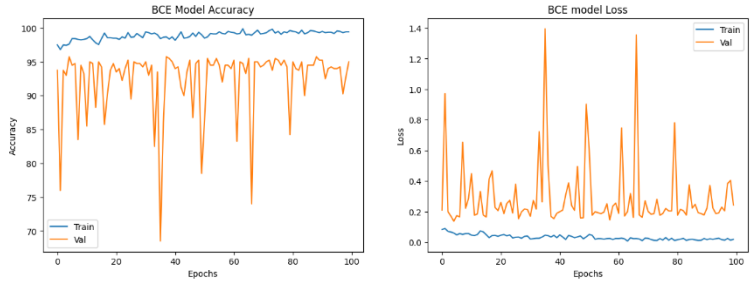


Fig. 9, 100 epoch training accuracy & Loss

```
Num 99 Take # 331 as test image.
  This model is 71.92% confident that the scan is abnormal and 28.08% confident that the scan is normal.
  Prediction is abnormal.
  Incorrect 😳
答對 51 個
```

Fig. 10　100 epoch accuracy result (51%正確率)

➢ **changing layer numbers**

分別用 1、2、3 層的 model 進行 training 與 100 個 test data 測試(epoch 固定為 30 個)

- **1layer**

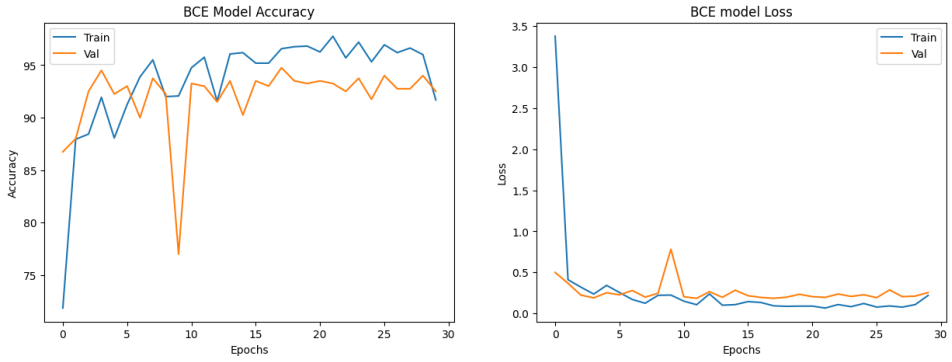


Fig. 11　1 layer training accuracy & Loss

```
  Correct 😊
Num 99 Take # 231 as test image.
  This model is 50.03% confident that the scan is abnormal and 49.97% confident that the scan is normal.
  Prediction is abnormal.
  Incorrect 😳
答對 53 個
```

Fig. 12　1 layer accuracy result (53%正確率)

- **2 layer**

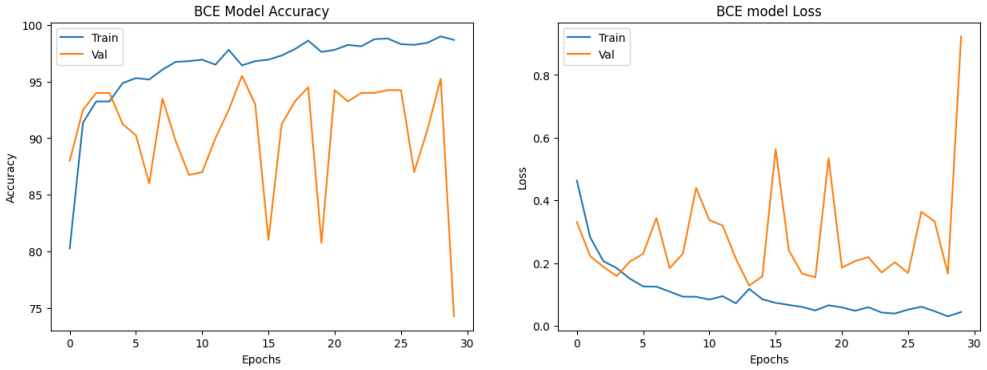


Fig. 13　2 layer training accuracy & Loss

```
Num 99 Take # 374 as test image.
  This model is 50.41% confident that the scan is abnormal and 49.59% confident that the scan is normal.
  Prediction is abnormal.
  Incorrect 😳
答對 50 個
```

Fig. 14　2 layer accuracy result (50%正確率)

- **3 layer**

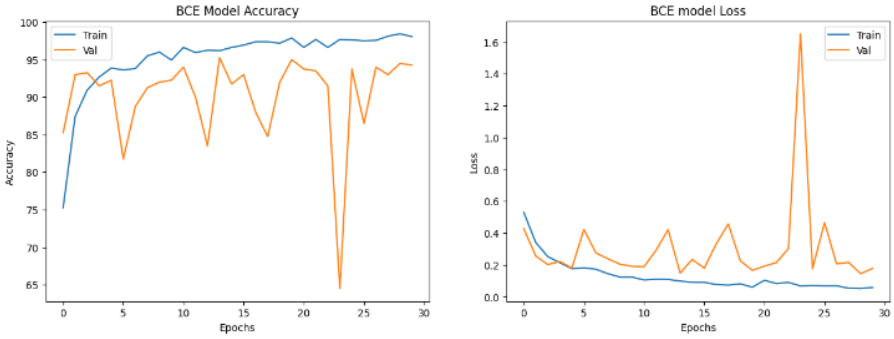


Fig. 15　3 layer training accuracy & Loss

```
Num 99 Take # 349 as test image.
  This model is 73.02% confident that the scan is abnormal
  Prediction is abnormal.
  Incorrect 😳
答對 56 個
```

Fig. 16　3 layer accuracy result (56%正確率)

Q2 總結:

1. 調整 epoch，似乎準確率有隨著 epoch 增加而變大，不過 30epoch 和 100epoch 的差異不大甚至還有下降的現象，或許 epoch 次數對這個 model 的影響並沒有那麼大，也有可能是 100 個 epoch 反而導致其對 training overfit 了才會變成這樣。
2. 調整 layer，目前將 layer 增加並沒有甚麼明顯趨勢產生，甚至這樣觀察起來 2 層的準確

對 train 和 test 的準確度還最低，可能改變 layer 對此 model 沒什麼影響，多測試幾次會呈現不同的答案。