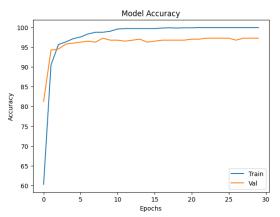
> Task A: Reduce Overfitting

若使用原本的 model(都使用 30 個 epoch)最後的結果會如下圖,會出現 overfitting 的狀況,training 的 accuracy 很高(100%左右)但 validation 的 accuracy 就低很多

Epoch 30



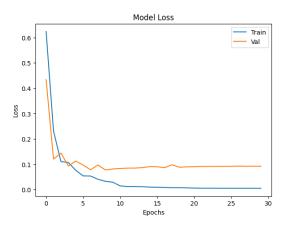


圖 1, 原本 model 的 accuracy 和 loss

```
import toroth.un as unimport toroth.un functional as F

class CommUnded(Una Modula):
    def __inst__(reif):
        super().__inst__()

        # | channel. and using 3x3 kernels for simplicity. 256*256
        self.comod = nn.Comv2d(1, 20. kernel_size*3, stride*1, pudding* same')
        self.comod = nn.Comv2d(2, 22. kernel_size*3, stride*1, pudding* same')
        self.comod = nn.Comv2d(32, 32. kernel_size*3, stride*1, pudding* same') # 128*128

        self.comod = nn.Comv2d(32, 32. kernel_size*3, stride*1, pudding* same') # 64*64

        self.comod = nn.Comv2d(32, 32. kernel_size*3, stride*1, pudding* same') # 64*64

        self.comod = nn.Mom2d(32, 32. kernel_size*3, stride*2) # 32*32

        tlattened_din = 32 * 32 * 32 # Schannelsi*232

        self.fool = nn.linear(Clattened_din, 32)
        self.fo(2 * nn.linear(Clattened_din, 32)
        self.fo(2 * nn.linear(Clattened_din, 32)
        self.fo(depout * nn.linear(Clattened_din, 32)
        self.fo(depout * nn.linear(Clattened_din, 32)
        self.pools(x)
        x = Freiu(celf.comv(x))
        x = self.pool3(x)

        x = Freiu(celf.comv(x))
        x = self.pool3(x)

        x = x.reshape(x.size(0), -1) # x.size(0) is the batch size

        x = Freiu(celf.fo(x))

        x = x.reshape(x.size(0), -1) # x.size(0) is the batch size

        x = Freiu(celf.fo(x))
```

圖 2, 原本 model 的架構

所以為了防止他繼續 overfitting,我選擇使用了 dropout 的方式,因為感覺此 model 問題不大, accuracy 也蠻高的,現在的問題只有 overfitting,所以想說就直接藉由減少他對 training data 的 fitting 程度就可以了。

```
我增加了兩行程式碼 self.dropout = nn.Dropout(0.6)
x = self.dropout(x)
```

讓 model 把部分 train 出來的 neuron 丟掉,防止他過度學習 train data 的特色,而在這裡我讓 model 把 6 成的 neuron 丟掉。

圖 3, 使用 dropout 的 model

最終結果如下,成功解決了 overfitting 的狀況,train 和 validation 的 accuracy 已經幾乎一樣了。

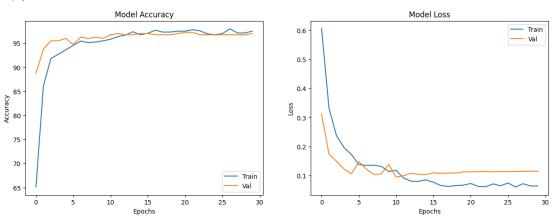
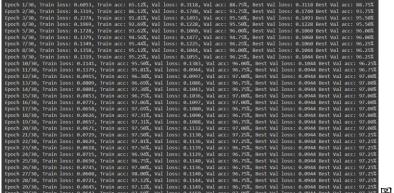


圖 3, 使用 drop out 的後的 accuracy 和 loss



■圖 4,更細節的測試結果

Discussion

總而言之在我使用了 Dropout 把一些 neuron 丟掉後, 出現了以下的情況

- 1. Accuracy: 實施 Dropout 後,我 train 和 validation 的 accuracy 變得幾乎相同了,也就代表這次比較沒有出現 overfitting 的現象。
- 2. Loss:在 loss 的部分反而沒有那麼明顯,雖然似乎 loss 有比原本還低一點,但實際上 loss 也一樣很快就沒辦法繼續下降了。可能 dropout 沒辦法用來降低 loss 吧。
- 3. Generalization: 從 accuracy 來看的話,理論上此 model 變得更 generalization,因為我把 model 改成這樣後, train 和 validation 的 accuracy 基本上是很接近一模一樣

的,都約97%左右,換句話說如果用來 test 其他 data 的話因為比較不會 overfitting , 所以拿還 test 理論上會有較好的表現。

Task B: Performance Comparison between CNN and ANN

Discussion

我分別使用了 class LinearModel and class ConvModel 最終 CNN 和 ANN 的差別如下

	feature extraction	training	model performance
	capabilities	speed	
CNN	較好(accuracy 較高)	2.35s/it	非常好
ANN	較差(accuracy 較低)	2.65s/it	不太好

1. feature extraction capabilities:

從結果中可以看出, CNN 的 accuracy 最終到了 97.25%, loss 則下降到 0.1052。這代表 CNN feature extraction capabilities 很好。

相比之下,ANN 模型的性能不如 CNN。ANN 的 accuracy 最終到了 94.50%,loss 則最終下降到 0.1694。雖然 ANN 也在一定程度上提高了性能,但它的性能仍然不及 CNN。代表 ANN 在圖像分類任務中的 feature extraction capabilities 不如 CNN。

此外本來 CNN model 的架構本來就是藉由提取 feature 進行簡化與優化的,所以 feature extraction capabilities 一定是 CNN 比較好。

2. training speed:

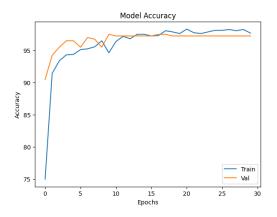
CNN 在每個周期中需要大約 2.35 秒,而 ANN 在每個周期中需要大約 2.73 秒。這代表出 CNN 在訓練速度上略微快於 ANN。這是因為 CNN 的卷積操作可以進行高效的並行計算,而 ANN 的全連接層需要更多的計算資源。

3. model performance:

根據最終的 accuracy 和 loss,可以看出 CNN 模型不管在 training 速度還是準確度和 loss 上都比 ANN 模型還強。此外從圖 6 和圖 8 的表較中可以看出,甚至在 ANN 中還有點出現 overfitting 的現象故 CNN 的表現比 ANN 好非常多。

Comvide Comv	
(pon2): NasPon2/2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False) (conv3): Gnov3/2d(x, yernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False) (fc1): Linear(in_features=3278, out_features=32) bias=True) (fc2): Linear(in_features=3278, out_features=32) bias=True) (fc2): Linear(in_features=3278, out_features=1) bias=True) (dropout): Dropout(p=0.6, inplace=False)) 100% Spoch 1/30, Train loss: 0.5075, Train acc: 75.00%, Val loss: 0.2270, Val acc: 90.50%, Best Val loss: 0.2270 Best Val acc: 90.50% Epoch 2/30, Train loss: 0.2318, Train acc: 93.35%, Val loss: 0.1217, Val acc: 94.25%, Best Val loss: 0.1417 Best Val acc: 90.50% Epoch 3/30, Train loss: 0.1757, Train acc: 93.35%, Val loss: 0.1127, Val acc: 95.50%, Best Val loss: 0.11037 Best Val acc: 96.50% Epoch 4/30, Train loss: 0.1572, Train acc: 93.35%, Val loss: 0.1137, Val acc: 95.50%, Best Val loss: 0.1037 Best Val acc: 96.50% Epoch 6/30, Train loss: 0.1181, Train acc: 94.35%, Val loss: 0.1806, Val acc: 96.50%, Best Val loss: 0.1037 Best Val acc: 96.50% Epoch 6/30, Train loss: 0.1141, Train acc: 95.25%, Val loss: 0.1808, Val acc: 96.50%, Best Val loss: 0.1096 Best Val acc: 96.50% Epoch 9/30, Train loss: 0.1213, Train acc: 95.25%, Val loss: 0.4084, Val acc: 97.60%, Best Val loss: 0.0976 Best Val acc: 96.50% Epoch 9/30, Train loss: 0.0922, Train acc: 95.50%, Val loss: 0.0976, Val acc: 97.50%, Best Val loss: 0.0976 Best Val acc: 97.60% Epoch 1/30, Train loss: 0.0922, Train acc: 95.50%, Val loss: 0.0982, Val acc: 97.50%, Best Val loss: 0.0976 Best Val acc: 97.60% Epoch 1/30, Train loss: 0.1042, Train acc: 95.50%, Val loss: 0.0990, Val acc: 97.50%, Best Val loss: 0.0976 Best Val acc: 97.60% Epoch 1/30, Train loss: 0.0835, Train acc: 97.50%, Val loss: 0.0990, Val acc: 97.25%, Best Val loss: 0.0978 Best Val acc: 97.50% Epoch 1/30, Train loss: 0.0835, Train acc: 97.50%, Val loss: 0.0990, Val acc: 97.25%, Best Val loss: 0.0908 Best Val acc: 97.50% Epoch 1/30, Train loss: 0.0663, Train acc: 90.50%, Val loss: 0.0990, Val acc: 97.25%, Best Val loss	(conv1): Conv2d(1, 32, kernel_size=(3, 3), stride=(1, 1), padding=same) (pool1): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
(conv3): Conv2d(23, 32, kernel_size=(3, 3), stride=(1, 1), padding=same) (pool3): MarPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False) (fc2): Linear(in_features=32768, out_features=32, bias=True) (fc2): Linear(in_features=32, out_features=1, bias=True) (dropout): Dropout(p=0.6, inplace=False)) 100% 30/30 [01:10-00.00, 2.356/R] Epoch 1/30, Train loss: 0.5075, Train acc: 91.46%, Val loss: 0.2270, Val acc: 90.56%, Best Val loss: 0.1417 Best Val acc: 90.56% Epoch 3/30, Train loss: 0.2318, Train acc: 91.46%, Val loss: 0.1417, Val acc: 94.25%, Best Val loss: 0.1127 Best Val acc: 94.25% Epoch 3/30, Train loss: 0.1572, Train acc: 94.38%, Val loss: 0.1127, Val acc: 95.56%, Best Val loss: 0.1127 Best Val acc: 95.56% Epoch 5/30, Train loss: 0.1572, Train acc: 94.38%, Val loss: 0.1018, Val acc: 95.56%, Best Val loss: 0.1008 Best Val acc: 96.56% Epoch 5/30, Train loss: 0.1420, Train acc: 94.38%, Val loss: 0.1018, Val acc: 95.56%, Best Val loss: 0.1008 Best Val acc: 96.56% Epoch 5/30, Train loss: 0.1442, Train acc: 94.25%, Val loss: 0.1018, Val acc: 95.56%, Best Val loss: 0.1008 Best Val acc: 96.56% Epoch 5/30, Train loss: 0.1420, Train acc: 95.56%, Val loss: 0.0084, Val acc: 97.66%, Set Set Val loss: 0.0084 Best Val acc: 97.66% Epoch 5/30, Train loss: 0.1213, Train acc: 95.56%, Val loss: 0.0084, Val acc: 97.66%, Set Set Val loss: 0.0085 Best Val acc: 97.66% Epoch 5/30, Train loss: 0.0062, Train acc: 96.36%, Val loss: 0.0084, Val acc: 97.56%, Best Val loss: 0.0086 Best Val acc: 97.66% Epoch 1/30, Train loss: 0.0063, Train acc: 96.38%, Val loss: 0.0081, Val acc: 97.56%, Best Val loss: 0.0082 Best Val acc: 97.56% Epoch 1/30, Train loss: 0.0063, Train acc: 97.56%, Val loss: 0.0093, Val acc: 97.25%, Best Val loss: 0.0082 Best Val acc: 97.56% Epoch 1/30, Train loss: 0.0663, Train acc: 97.56%, Val loss: 0.0093, Val acc: 97.25%, Best Val loss: 0.0092 Best Val acc: 97.56% Epoch 1/30, Train loss: 0.0663, Train acc: 97.56%, Val loss: 0.0093, Val acc: 97.25%, Best Val loss: 0.0092 Best Val acc: 97.56% Epoch 1/3	
(fc2): Linear(in features=32,0 out features=32, bias=True) (fc2): Linear(in features=32,0 out features=1, bias=True) (dropout): Dropout(p=0.6, inplace=False)) 100% 30/30 [01:10-00.00, 2.356/fl] Epoch 1/30, Train loss: 0.5075, Train acc: 91.454, Val loss: 0.2270, Val acc: 90.50%, Best Val loss: 0.2270 Best Val acc: 90.50% Epoch 1/30, Train loss: 0.2318, Train acc: 91.454, Val loss: 0.1417, Val acc: 94.25%, Best Val loss: 0.1417 Best Val acc: 90.50% Epoch 3/30, Train loss: 0.1757, Train acc: 91.354, Val loss: 0.1377, Val acc: 95.50%, Best Val loss: 0.1127 Best Val acc: 92.55% Epoch 3/30, Train loss: 0.1572, Train acc: 94.38%, Val loss: 0.1127, Val acc: 95.50%, Best Val loss: 0.1127 Best Val acc: 95.50% Epoch 5/30, Train loss: 0.1421, Train acc: 94.38%, Val loss: 0.1018, Val acc: 95.50%, Best Val loss: 0.1006 Best Val acc: 95.50% Epoch 7/30, Train loss: 0.1442, Train acc: 95.25%, Val loss: 0.0066, 506, 506%, Best Val loss: 0.0068 Best Val acc: 95.50% Epoch 7/30, Train loss: 0.1421, Train acc: 95.50%, Val loss: 0.0066, 75%, Best Val loss: 0.0084 Best Val acc: 97.60% Epoch 9/30, Train loss: 0.1114, Train acc: 95.50%, Val loss: 0.0066, 75%, Best Val loss: 0.0084 Best Val acc: 97.60% Epoch 9/30, Train loss: 0.0052, Train acc: 95.50%, Val loss: 0.0075, Val acc: 97.50%, Best Val loss: 0.0076 Best Val acc: 97.60% Epoch 9/30, Train loss: 0.0068, Train acc: 96.30%, Val loss: 0.0080, Val acc: 97.50%, Best Val loss: 0.0076 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0068, Train acc: 97.50%, Val loss: 0.00930, Val acc: 97.25%, Best Val loss: 0.0092 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0068, Train acc: 97.50%, Val loss: 0.00930, Val acc: 97.25%, Best Val loss: 0.0092 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0068, Train acc: 97.50%, Val loss: 0.00930, Val acc: 97.25%, Best Val loss: 0.0092 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0068, Train acc: 97.50%, Val loss: 0.00930, Val acc: 97.25%, Best Val loss: 0.0092 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0068, Train acc: 97.50%, Val loss: 0.0	(conv3): Conv2d(32, 32, kernel_size=(3, 3), stride=(1, 1), padding=same)
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(dropout): Dropout(p=0.6, inplace=False)) 100% Spoch 1/30, Train loss: 0.5075, Train acc: 79.60%, Val loss: 0.2276, Val acc: 90.50%, Best Val loss: 0.2276 Best Val acc: 90.50% Epoch 1/30, Train loss: 0.2318, Train acc: 91.45%, Val loss: 0.1274, Val acc: 94.25%, Best Val loss: 0.1417 Best Val acc: 94.25% Epoch 3/30, Train loss: 0.1575, Train acc: 91.45%, Val loss: 0.1177, Val acc: 94.25%, Best Val loss: 0.1127 Best Val acc: 94.25% Epoch 3/30, Train loss: 0.1572, Train acc: 94.31%, Val loss: 0.1317, Val acc: 95.50%, Best Val loss: 0.1127 Best Val acc: 95.50% Epoch 5/30, Train loss: 0.1572, Train acc: 94.33%, Val loss: 0.1019, Val acc: 95.50%, Best Val loss: 0.1086 Best Val acc: 95.50% Epoch 5/30, Train loss: 0.1442, Train acc: 95.25%, Val loss: 0.1010, Val acc: 95.50%, Best Val loss: 0.1086 Best Val acc: 95.50% Epoch 7/30, Train loss: 0.1421, Train acc: 95.25%, Val loss: 0.0906, Val acc: 97.60%, Sest Val loss: 0.0908 Best Val acc: 97.60% Epoch 9/30, Train loss: 0.1143, Train acc: 95.50%, Val loss: 0.0976, Val acc: 97.50%, Best Val loss: 0.0908 Best Val acc: 97.60% Epoch 9/30, Train loss: 0.185, Train acc: 96.30%, Val loss: 0.1011, Val acc: 97.50%, Best Val loss: 0.0976 Best Val acc: 97.60% Epoch 9/30, Train loss: 0.185, Train acc: 96.30%, Val loss: 0.1011, Val acc: 97.50%, Best Val loss: 0.0976 Best Val acc: 97.60% Epoch 11/30, Train loss: 0.0063, Train acc: 96.30%, Val loss: 0.0911, Val acc: 97.50%, Best Val loss: 0.0976 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0063, Train acc: 97.50%, Val loss: 0.0990, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 13/30, Train loss: 0.0063, Train acc: 97.50%, Val loss: 0.00930, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 13/30, Train loss: 0.0068, Train acc: 97.50%, Val loss: 0.00930, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 17/30, Train loss: 0.0068, Train acc: 97.50%, Val loss: 0.00930, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 17/30, Train loss: 0.0068, Train acc: 97.50%, Val	
Epoch 1/30, Train loss: 0.5075, Train acc: 75.00%, Val loss: 0.2270, Val acc: 90.50%, Best Val loss: 0.2270 Best Val acc: 90.50% Epoch 2/30, Train loss: 0.2318, Train acc: 91.36%, Val loss: 0.1417, Val acc: 94.25%, Best Val loss: 0.1417 Best Val acc: 94.25%, Epoch 3/30, Train loss: 0.1175, Train acc: 93.36%, Val loss: 0.1127, Val acc: 95.50%, Best Val loss: 0.1127 Best Val acc: 95.50% Epoch 4/30, Train loss: 0.1572, Train acc: 94.38%, Val loss: 0.1037, Val acc: 96.50%, Best Val loss: 0.1127 Best Val acc: 95.50% Epoch 6/30, Train loss: 0.1431, Train acc: 94.38%, Val loss: 0.1080, Val acc: 96.50%, Best Val loss: 0.1087 Best Val acc: 96.50% Epoch 6/30, Train loss: 0.11213, Train acc: 95.25%, Val loss: 0.1084, Val acc: 95.50%, Best Val loss: 0.1086 Best Val acc: 96.50% Epoch 6/30, Train loss: 0.1041, Train acc: 95.25%, Val loss: 0.0484, Val acc: 97.06%, Best Val loss: 0.0976 Best Val acc: 96.50% Epoch 6/30, Train loss: 0.0922, Train acc: 95.50%, Val loss: 0.0976, Val acc: 95.50%, Best Val loss: 0.0976 Best Val acc: 97.60% Epoch 17/30, Train loss: 0.0922, Train acc: 95.50%, Val loss: 0.0976, Val acc: 97.50%, Best Val loss: 0.0976 Best Val acc: 97.60% Epoch 17/30, Train loss: 0.1043, Train acc: 96.50%, Val loss: 0.1044, Val acc: 97.50%, Best Val loss: 0.0976 Best Val acc: 97.50% Epoch 17/30, Train loss: 0.1043, Train acc: 96.50%, Val loss: 0.0959, Val acc: 97.25%, Best Val loss: 0.0976 Best Val acc: 97.50% Epoch 17/30, Train loss: 0.0953, Train acc: 97.10%, Val loss: 0.0959, Val acc: 97.25%, Best Val loss: 0.0958 Best Val acc: 97.50% Epoch 17/30, Train loss: 0.0953, Train acc: 97.50%, Val loss: 0.0930, Val acc: 97.25%, Best Val loss: 0.0958 Best Val acc: 97.50% Epoch 17/30, Train loss: 0.0665, Train acc: 97.50%, Val loss: 0.0930, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 17/30, Train loss: 0.0665, Train acc: 97.50%, Val loss: 0.0930, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 17/30, Train loss: 0.0665, Train acc: 97.50%, Val loss: 0.0930, Val acc: 97.25%, Best Val loss:	
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Epoch 3/30, Train loss: 0.1727, Train acc: 94.38%, Val loss: 0.1127, Val acc: 95.50% Best Val loss: 0.1127 Best Val acc: 95.50% Epoch 5/30, Train loss: 0.1872, Train acc: 94.38%, Val loss: 0.1217, Val acc: 96.50% Best Val loss: 0.1086 Best Val acc: 96.50% Epoch 5/30, Train loss: 0.1831, Train acc: 94.38%, Val loss: 0.1010, Val acc: 96.50% Best Val loss: 0.1006 Best Val acc: 96.50% Epoch 5/30, Train loss: 0.1422, Train acc: 95.25%, Val loss: 0.1010, Val acc: 95.50%, Best Val loss: 0.1006 Best Val acc: 95.50% Epoch 5/30, Train loss: 0.1213, Train acc: 95.50%, Val loss: 0.0908, Val acc: 97.60% Best Val loss: 0.0908 Best Val acc: 97.60% Epoch 8/30, Train loss: 0.1021, Train acc: 95.50%, Val loss: 0.0976, Val acc: 97.60% Best Val loss: 0.0976 Best Val acc: 97.60% Epoch 9/30, Train loss: 0.0972, Train acc: 96.50%, Val loss: 0.1011, Val acc: 97.50%, Best Val loss: 0.0976 Best Val acc: 97.60% Epoch 9/30, Train loss: 0.0976 Best Val acc: 97.60%, Val loss: 0.1011, Val acc: 97.50%, Best Val loss: 0.0976 Best Val acc: 97.60% Epoch 11/30, Train loss: 0.0976 Best Val acc: 97.60%, Val loss: 0.0976, Val acc: 97.50%, Best Val loss: 0.0976 Best Val acc: 97.50%, Epoch 11/30, Train loss: 0.0750, Train acc: 96.30%, Val loss: 0.0892, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50%, Epoch 11/30, Train loss: 0.0750, Train acc: 97.50%, Val loss: 0.0930, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50%, Epoch 11/30, Train loss: 0.0660, Train acc: 97.50%, Val loss: 0.0930, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50%, Epoch 11/30, Train loss: 0.0660, Train acc: 97.50%, Val loss: 0.0934, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50%, Epoch 11/30, Train loss: 0.0660, Train acc: 97.50%, Val loss: 0.0934, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50%, Epoch 11/30, Train loss: 0.0660, Train acc: 97.50%, Val loss: 0.0934, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50%, Epoch 11/30, Train loss: 0.0660, Train acc: 97.50%, Val loss: 0.0934, Val acc: 97.25%, Best Val lo	
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Epoch 5/30, Train loss: 0.1481, Train acc: 94.38%, Val loss: 0.1086, Val acc: 95.50%, Best Val loss: 0.1086 Est Val acc: 95.50% Epoch 7/30, Train loss: 0.1086 Est Val acc: 95.50% Epoch 7/30, Train loss: 0.1086 Est Val acc: 95.50% Epoch 8/30, Train loss: 0.1086 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.1081, Train acc: 95.50%, Val loss: 0.0984, Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.60% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Epoch 8/30, Train acc: 97.50% Val loss: 0.0997, Val acc: 97.50% Epoch 8/30, Train loss: 0.0976 Epoch 8/30, Train loss: 0.0958 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0958 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0958 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0958 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0958 Est Val acc: 97.50% Epoch 8/30, Train loss: 0.0958 Est Val acc: 97.50% Epoch 8/30, Train loss:	
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Epoch 8/30, Train loss: 0.022, Train acc: 95.50%, Val loss: 0.0976, Val acc: 96.75%, Best Val loss: 0.0976 Best Val acc: 97.00% Epoch 10/30, Train loss: 0.0976 Best Val acc: 97.00% Val loss: 0.0976 Best Val acc: 97.00% Epoch 10/30, Train loss: 0.0976 Best Val acc: 97.00% Epoch 10/30, Train loss: 0.0976 Best Val acc: 97.50% Epoch 10/30, Train loss: 0.0976 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0976 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0976 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0975 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0975 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0975, Train acc: 97.19%, Val loss: 0.0991, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0665, Train acc: 97.50%, Val loss: 0.0990, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0663, Train acc: 97.50%, Val loss: 0.0990, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 16/30, Train loss: 0.0663, Train acc: 97.25%, Val loss: 0.0990, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 16/30, Train loss: 0.0668, Train acc: 97.25%, Val loss: 0.0990, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 16/30, Train loss: 0.0668, Train acc: 97.25%, Val loss: 0.0991, Val acc: 97.50%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 18/30, Train loss: 0.0668, Train acc: 97.60%, Val loss: 0.0991, Val acc: 97.50%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 18/30, Train loss: 0.0891, Val acc: 90.991, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 18/30, Train loss: 0.0891, Val acc: 90.991, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 18/30, Train loss: 0.0891, Val acc: 90.991, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 18/30, Train loss: 0.0891, Val acc: 90.991, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 27/30, Train loss: 0.0891, Val acc: 90.991, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.	
Epoch 9/30, Train loss: 0.0922, Train acc: 96.50%, Val loss: 0.1444, Val acc: 97.50%, Best Val loss: 0.0976 Best Val acc: 97.60% Epoch 11/30, Train loss: 0.076 Best Val acc: 97.60% Epoch 11/30, Train loss: 0.0750 Best Val acc: 97.50%, Best Val loss: 0.0892 Best Val loss: 0.0892 Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0893 Best Val acc: 97.50% Epoch 11/30, Train loss: 0.0893 Best Val acc: 97.50% Epoch 13/30, Train loss: 0.0893 Best Val acc: 97.50% Epoch 13/30, Train loss: 0.0893 Best Val acc: 97.50% Epoch 13/30, Train loss: 0.0893 Best Val acc: 97.50%, Val loss: 0.08930, Val acc: 97.25%, Best Val loss: 0.0893 Best Val acc: 97.50% Epoch 15/30, Train loss: 0.0893 Best Val acc: 97.50%, Val loss: 0.0893 Best Val acc: 97.25%, Best Val loss: 0.0893 Best Val acc: 97.50% Epoch 15/30, Train loss: 0.0893, Train acc: 97.50%, Val loss: 0.0893, Val acc: 97.25%, Best Val loss: 0.0893 Best Val acc: 97.50% Epoch 17/30, Train loss: 0.0893, Train acc: 97.50%, Val loss: 0.0895, Val acc: 97.50%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 18/30, Train loss: 0.0868, Train acc: 97.60%, Val loss: 0.0895, Val acc: 97.50%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 18/30, Train loss: 0.0560, Train acc: 97.60%, Val loss: 0.0951, Val acc: 97.50%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 18/30, Train loss: 0.0560, Train acc: 97.60%, Val loss: 0.0951, Val acc: 97.50%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 28/30, Train loss: 0.0560, Train acc: 97.60%, Val loss: 0.0951, Val acc: 97.50%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 28/30, Train loss: 0.0560, Train acc: 97.60%, Val loss: 0.0951, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 28/30, Train loss: 0.054, Train acc: 97.60%, Val loss: 0.0951, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 28/30, Train loss: 0.054, Train acc: 97.50%, Val loss: 0.0951, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 28/30, Train loss: 0.054, Train acc: 90.60%, Val loss: 0.0951, Val ac	
Epoch 10/30, Train loss: 0.1365, Train acc: 94.62%, Val loss: 0.0911, Val acc: 97.25%, Best Val loss: 0.0976 Best Val acc: 97.56% Epoch 11/30, Train loss: 0.0982 Best Val acc: 97.56% Epoch 12/30, Train loss: 0.0982 Best Val acc: 97.56% Epoch 12/30, Train loss: 0.0982 Best Val acc: 97.56% Epoch 12/30, Train loss: 0.0982, Train acc: 96.18%, Val loss: 0.0991, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 12/30, Train loss: 0.0862, Train acc: 96.18%, Val loss: 0.0990, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 12/30, Train loss: 0.0663, Train acc: 97.56%, Val loss: 0.0990, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 16/30, Train loss: 0.0663, Train acc: 97.56%, Val loss: 0.0990, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 16/30, Train loss: 0.0668, Train acc: 97.25%, Val loss: 0.0990, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 16/30, Train loss: 0.0668, Train acc: 97.25%, Val loss: 0.0990, Val acc: 97.56%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 18/30, Train loss: 0.0868, Train acc: 97.66%, Val loss: 0.0991, Val acc: 97.56%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 18/30, Train loss: 0.0851, Train acc: 97.66%, Val loss: 0.0991, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 12/30, Train loss: 0.0851, Train acc: 97.66%, Val loss: 0.0920, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 22/30, Train loss: 0.0854, Train acc: 97.65%, Val loss: 0.0921, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 22/30, Train loss: 0.0854, Train acc: 97.75%, Val loss: 0.0917, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 22/30, Train loss: 0.0891, Train acc: 97.75%, Val loss: 0.0917, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 22/30, Train loss: 0.0891, Train acc: 97.88%, Val loss: 0.0918, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.56% Epoch 22/30, Train loss: 0.0891, Train acc: 98.12%, Val loss: 0.091	
Epoch 11/30, Train loss: 0.1043, Train acc: 97.60%, Val loss: 0.0892, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 13/30, Train loss: 0.0753, Train acc: 97.10%, Val loss: 0.08930, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 13/30, Train loss: 0.0685, Train acc: 97.50%, Val loss: 0.08930, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 15/30, Train loss: 0.0685, Train acc: 97.50%, Val loss: 0.08930, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 15/30, Train loss: 0.0685, Train acc: 97.50%, Val loss: 0.0894, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 15/30, Train loss: 0.0895, Train acc: 97.50%, Val loss: 0.0895, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 15/30, Train loss: 0.0665, Train acc: 97.50%, Val loss: 0.0895, Val acc: 97.50%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 15/30, Train loss: 0.0665, Train acc: 97.65%, Val loss: 0.0951, Val acc: 97.50%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 25/30, Train loss: 0.0655, Train acc: 97.65%, Val loss: 0.0951, Val acc: 97.50%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 25/30, Train loss: 0.0554, Train acc: 97.65%, Val loss: 0.0952, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 25/30, Train loss: 0.0534, Train acc: 97.55%, Val loss: 0.0952, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 25/30, Train loss: 0.0534, Train acc: 97.55%, Val loss: 0.0915, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 25/30, Train loss: 0.0501, Train acc: 97.50%, Val loss: 0.0915, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 25/30, Train loss: 0.0501, Train acc: 97.50%, Val loss: 0.0915, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 25/30, Train loss: 0.0501, Train acc: 97.50%, Val loss: 0.0915, Val acc: 97.25%, Best Val loss: 0.0892 Best Val acc: 97.50% Epoch 25/30, Train loss: 0.0501, Train acc: 90.25%, Val loss: 0.0915, Val acc: 97.25%, Best V	
Epoch 13/30, Train loss: 0.0762, Train acc: 97.60%, Val loss: 0.0930, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 15/30, Train loss: 0.0805 Best Val acc: 97.50%, Val loss: 0.0803 Best Val acc: 97.50% Epoch 15/30, Train loss: 0.0803 Best Val acc: 97.50%, Val loss: 0.0804, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 15/30, Train loss: 0.0805, Train acc: 97.50%, Val loss: 0.0804, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 17/30, Train loss: 0.0805, Train acc: 97.50%, Val loss: 0.0805, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 17/30, Train loss: 0.0805, Train acc: 97.50%, Val loss: 0.0805, Val acc: 97.50%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 19/30, Train loss: 0.0805, Train acc: 97.62%, Val loss: 0.0805, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 29/30, Train loss: 0.0805, Train acc: 97.62%, Val loss: 0.0925, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 29/30, Train loss: 0.0804, Train acc: 97.50%, Val loss: 0.0922, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 29/30, Train loss: 0.0804, Train acc: 97.50%, Val loss: 0.0916, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 29/30, Train loss: 0.0804, Train acc: 97.55%, Val loss: 0.0916, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 29/30, Train loss: 0.0804, Train acc: 97.50%, Val loss: 0.0912, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 29/30, Train loss: 0.0804, Train acc: 97.80%, Val loss: 0.0912, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 29/30, Train loss: 0.0804, Train acc: 97.80%, Val loss: 0.0912, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 29/30, Train loss: 0.0804, Train acc: 98.25%, Val loss: 0.0912, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% Epoch 29/30, Train loss: 0.0486, Train acc: 98.25%, Val loss: 0.08028, Val acc: 97.25%, Best Val loss: 0.0802 Best Val acc: 97.50% E	
Epoch 14/30, Train loss: 0.6663, Train acc: 97.50%, Val loss: 0.6900, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 15/30, Train loss: 0.6663, Train acc: 97.50%, Val loss: 0.6904, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 16/30, Train loss: 0.6808, Train acc: 97.25%, Val loss: 0.6960, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 16/30, Train loss: 0.6668, Train acc: 97.85%, Val loss: 0.6960, Val acc: 97.50%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 18/30, Train loss: 0.6868, Train acc: 97.86%, Val loss: 0.6916, Val acc: 97.50%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 18/30, Train loss: 0.6861, Train acc: 97.62%, Val loss: 0.6916, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 20/30, Train loss: 0.6894, Train acc: 97.62%, Val loss: 0.6920, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 22/30, Train loss: 0.6894, Train acc: 97.75%, Val loss: 0.6918, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 22/30, Train loss: 0.6894, Train acc: 97.75%, Val loss: 0.6918, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 22/30, Train loss: 0.6891, Train acc: 97.85%, Val loss: 0.6917, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 22/30, Train loss: 0.6891, Train acc: 97.85%, Val loss: 0.6918, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 22/30, Train loss: 0.6891, Train acc: 98.25%, Val loss: 0.6918, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 26/30, Train loss: 0.6891, Train acc: 98.12%, Val loss: 0.6918, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Fpoch 26/30, Train loss: 0.6468, Train acc: 98.12%, Val loss: 0.6929, Val acc: 97.25%, Best Val loss: 0.6928 Best Val acc: 97.50% Fpoch 27/30, Train loss: 0.6468, Train acc: 98.26%, Val loss: 0.6929, Val acc: 97.25%, Best Val loss: 0.6928 Best Val acc: 97.25% Best Val loss: 0.6928 Best Val acc: 97.50% Fpoch 27/30, Train loss: 0.6468, Train acc: 98.26%, V	
Epoch 15/30, Train loss: 0.0663, Train acc: 97.50%, Val loss: 0.0694, Val acc: 97.25%, Best Val loss: 0.0892 Eest Val acc: 97.50% Epoch 15/30, Train loss: 0.0892 Eest Val acc: 97.50% Epoch 15/30, Train loss: 0.0892 Eest Val acc: 97.50% Epoch 17/30, Train loss: 0.0895 Eest Val acc: 97.50% Epoch 17/30, Train loss: 0.0865, Train acc: 98.60%, Val loss: 0.0895, Val acc: 97.50% Best Val loss: 0.0892 Eest Val acc: 97.50% Epoch 19/30, Train loss: 0.0895, 0.0865, Val loss: 0.0895, Val acc: 97.50% Best Val loss: 0.0892 Eest Val acc: 97.50% Epoch 19/30, Train loss: 0.0895, Train acc: 97.60%, Val loss: 0.0895, Val acc: 97.25%, Best Val loss: 0.0892 Eest Val acc: 97.50% Epoch 29/30, Train loss: 0.0893, Train acc: 97.50%, Val loss: 0.0991, Val acc: 97.25%, Best Val loss: 0.0892 Eest Val acc: 97.50% Epoch 29/30, Train loss: 0.0894, Train acc: 97.53%, Val loss: 0.0922, Val acc: 97.25%, Best Val loss: 0.0892 Eest Val acc: 97.50% Epoch 29/30, Train loss: 0.0894, Train acc: 97.50%, Val loss: 0.0912, Val acc: 97.25%, Best Val loss: 0.0892 Eest Val acc: 97.50% Epoch 29/30, Train loss: 0.0892, Train acc: 97.80%, Val loss: 0.0912, Val acc: 97.25%, Best Val loss: 0.0892 Eest Val acc: 97.50% Epoch 29/30, Train loss: 0.0891, Val acc: 97.25%, Best Val loss: 0.0892 Eest Val acc: 97.50% Epoch 29/30, Train loss: 0.0891, Val acc: 97.25%, Epoch 29/30, Train loss: 0.0891, Val acc: 97.50% Epoch 29/30, Train loss: 0.0891, Train acc: 98.12%, Val loss: 0.0918, Val acc: 97.25%, Best Val loss: 0.0892 Eest Val acc: 97.50% Epoch 29/30, Train loss: 0.0486, Train acc: 98.12%, Val loss: 0.0892, Val acc: 97.25%, Best Val loss: 0.0892 Eest Val acc: 97.50% Epoch 29/30, Train loss: 0.0486, Train acc: 98.25%, Val loss: 0.0892, Val acc: 97.25%, Eest Val loss: 0.0892 Eest Val acc: 97.50% Epoch 29/30, Train loss: 0.0486, Train acc: 98.25%, Val loss: 0.0893, Val acc: 97.25%, Eest Val loss: 0.0892 Eest Val acc: 97.50% Epoch 29/30, Train loss: 0.0486, Train acc: 98.26%, Val loss: 0.08930, Val acc: 97.25%, Eest Val loss: 0.0892 Eest Val acc: 97.50%	
Epoch 16/30, Train loss: 0.6389, Train acc: 97.25%, Val loss: 0.6960, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Epoch 17/30, Train loss: 0.6686, Train acc: 97.35%, Val loss: 0.69815, Val acc: 97.50%, Best Val loss: 0.6892 Best Val acc: 97.50% Epoch 18/30, Train loss: 0.6988, Train acc: 98.60%, Val loss: 0.6916, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Epoch 18/30, Train loss: 0.6981, Train acc: 97.60%, Val loss: 0.6920, Val acc: 97.25%, Best Val loss: 0.6982 Best Val acc: 97.50% Epoch 20/30, Train loss: 0.6934, Train acc: 97.60%, Val loss: 0.6920, Val acc: 97.25%, Best Val loss: 0.6982 Best Val acc: 97.50% Epoch 22/30, Train loss: 0.6934, Train acc: 97.50%, Val loss: 0.6920, Val acc: 97.25%, Best Val loss: 0.6982 Best Val acc: 97.50% Epoch 22/30, Train loss: 0.6934, Train acc: 97.75%, Val loss: 0.6918, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Epoch 22/30, Train loss: 0.6937, Train acc: 97.60%, Val loss: 0.6918, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Epoch 22/30, Train loss: 0.6931, Train acc: 97.80%, Val loss: 0.6918, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Epoch 22/30, Train loss: 0.6931, Train acc: 98.25%, Val loss: 0.6918, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Epoch 22/30, Train loss: 0.6931, Train acc: 98.12%, Val loss: 0.6923, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Epoch 22/30, Train loss: 0.4466, Train acc: 98.12%, Val loss: 0.6927, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Epoch 22/30, Train loss: 0.4466, Train acc: 98.20%, Val loss: 0.6930, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Epoch 22/30, Train loss: 0.4467, Train acc: 98.00%, Val loss: 0.6930, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Epoch 22/30, Train loss: 0.4466, Train acc: 98.00%, Val loss: 0.6930, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.50% Epoch 22/30, Train loss: 0.4466, Train acc: 98.25%, Val loss: 0.6930, Val acc: 97.25%, Best Val	
Epoch 18/30, Train loss: 0.6568, Train acc: 98.86%, Val loss: 0.6916, Val acc: 97.56%, Best Val loss: 0.6892 Best Val acc: 97.56% Epoch 19/30, Train loss: 0.6958, Train acc: 97.86%, Val loss: 0.6926, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.56% Epoch 20/30, Train loss: 0.6938, Train acc: 97.65%, Val loss: 0.6920, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.56% Epoch 21/30, Train loss: 0.6934, Train acc: 98.31%, Val loss: 0.6921, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.56% Epoch 22/30, Train loss: 0.6937, Train acc: 97.55%, Val loss: 0.6918, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.55% Epoch 22/30, Train loss: 0.6897, Train acc: 97.65%, Val loss: 0.6918, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.55% Epoch 22/30, Train loss: 0.6931, Train acc: 97.85%, Val loss: 0.6918, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.55% Epoch 25/30, Train loss: 0.6931, Train acc: 98.12%, Val loss: 0.6923, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.55% Epoch 25/30, Train loss: 0.6486, Train acc: 98.12%, Val loss: 0.6927, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.55% Epoch 25/30, Train loss: 0.6446, Train acc: 98.12%, Val loss: 0.6928, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.55% Epoch 25/30, Train loss: 0.6446, Train acc: 98.25%, Val loss: 0.6998, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.56% Epoch 25/30, Train loss: 0.6446, Train acc: 98.60%, Val loss: 0.6998, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.56% Epoch 25/30, Train loss: 0.6488, Train acc: 98.05%, Val loss: 0.6998, Val acc: 97.25%, Best Val loss: 0.6892 Best Val acc: 97.56%	
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	cpoch 39/30, 1rain 1055: 0.0516, 1rain acc: 9/.09%, val 1055: 0.0936, Val acc: 9/.25%, Best Val 1055: 0.0892 Best Val acc: 9/.50%

圖 5, CNN 花的時間、loss、accuracy 等等細項



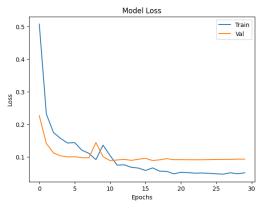


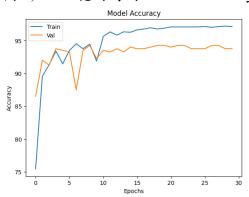
圖 6, CNN 的 accuracy 和 loss

```
LinearModel(
(flatten): Flatten(start_dim=1, end_dim=-1)
(fc1): Linear(in_features=65536, out_features=32, bias=True)
(fc2): Linear(in_features=32, out_features=32, bias=True)
(fc3): Linear(in_features=32, out_features=32, bias=True)
(fc4): Linear(in_features=32, out_features=1, bias=True)
)

100%
30/30 [00:11<00:00, 2.64il/s]
```

```
poch 17/80, Train loss: 0.2014, Train acc: 25.44%, Val loss: 0.3716, Val acc: 06.50%, Best Val loss: 0.2724 Best Val acc: 26.00% Epoch 47/80, Train loss: 0.2014, Train acc: 26.00%, Epoch 47/80, Train loss: 0.2024, Train acc: 27.20%, Val loss: 0.2724, Val acc: 27.20%, Epoch 47/80, Train loss: 0.2024, Train acc: 27.20%, Val loss: 0.2724, Val acc: 27.20%, Epoch 47/80, Train loss: 0.2025, Train acc: 27.20%, Val loss: 0.2724, Val acc: 27.20%, Epoch 47/80, Train loss: 0.2025, Train acc: 27.20%, Val loss: 0.1875, Val acc: 27.20%, Epoch 47/80, Train loss: 0.2025, Train acc: 27.20%, Val loss: 0.1885, Val acc: 29.20%, Epoch 47/80, Train loss: 0.2025, Train acc: 27.20%, Val loss: 0.1885, Val acc: 29.20%, Epoch 47/80, Train loss: 0.2025, Train acc: 27.20%, Val loss: 0.1885, Epoch 47/80, Train loss: 0.2025, Train acc: 27.20%, Val loss: 0.1892, Val acc: 29.20%, Epoch 47/80, Train loss: 0.2025, Train acc: 27.20%, Val loss: 0.2025, Val acc: 27.20%, Epoch 47/80, Train loss: 0.1874, Train acc: 27.20%, Val loss: 0.2025, Val acc: 27.20%, Epoch 47/80, Train loss: 0.1874, Train acc: 27.20%, Epoch 47/80, Train loss: 0.2024, Train acc: 27.20%, Val loss: 0.2029, Val acc: 27.20%, Epoch 47/80, Train loss: 0.2024, Train acc: 27.20%, Val loss: 0.2029, Val acc: 27.20%, Epoch 47/80, Train loss: 0.2024, Train acc: 27.20%, Val loss: 0.2029, Val acc: 27.20%, Epoch 47/80, Train loss: 0.1024, Train acc: 27.20%, Val loss: 0.2029, Val acc: 27.20%, Epoch 47/80, Train loss: 0.2029, Train acc: 27.20%, Val acc: 27.20%, Epoch 47/20, Train loss: 0.1026, Train acc: 27.20%, Val acc: 27.20%, Epoch 47/20, Train loss: 0.1026, Train acc: 27.20%, Val acc: 27.20%, Epoch 47/20, Train loss: 0.1026, Train acc: 27.20%, Val acc: 27.20%, Epoch 47/20, Train loss: 0.1026, Train acc: 27.20%, Val acc: 27.20%, Epoch 47/20%, Train loss: 0.1026, Train acc: 27.20%, Val acc: 27.20%, Epoch 47/20%, Train loss: 0.1026, Train acc: 27.20%, Val acc: 27.20%, Val acc: 27.20%, Epoch 47/20%, Train loss: 0.1026, Train acc: 27.20%, Val acc: 27.20%, Val acc: 27.20%, Epoch 47/20%, Train lo
```

圖 7, ANN 花的時間、loss、accuracy 等等細項



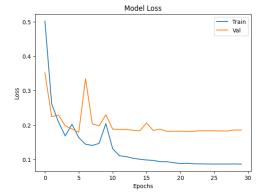
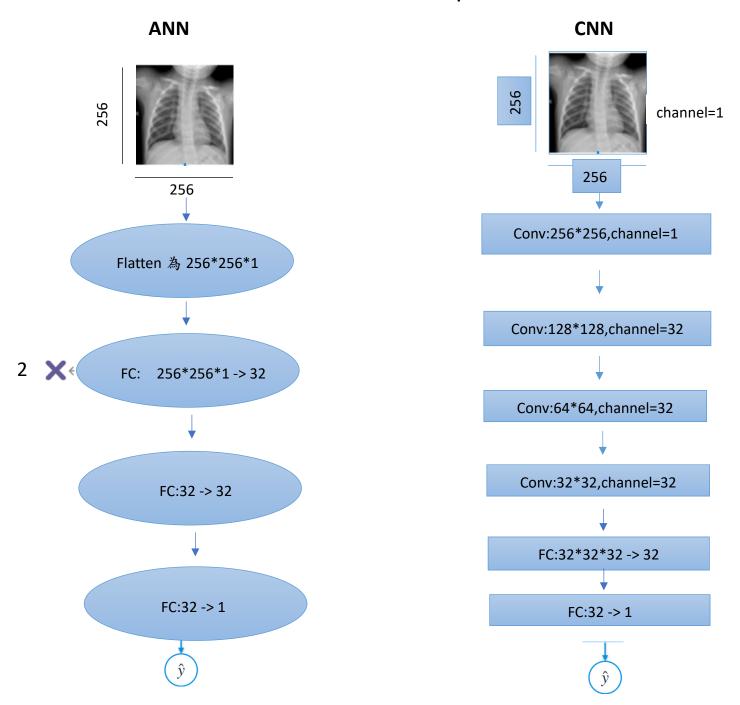


圖 8, ANN 的 accuracy 和 loss

Architecture Description



Task C: Global Average Pooling in CNNs

> Explanation:

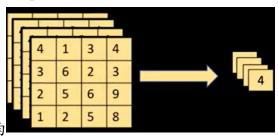


圖 9, GAP 示意圖, 每個 channel 取平均

Global Average Pooling (GAP) 是一種在卷積神經網絡 (CNN) 中用於特徵提取的技術。它的主要優勢在於它可以自動消除對輸入特徵數目的需求,而不需要手動確定特徵數目。

GAP 的運作方式如下:

在 CNN 的最後一個卷積層時,GAP 會對每個 channel 的特徵圖進行平均化,讓每個通道的特徵都被壓縮成一個單一的數值。最終這些平均值的集合形成了一個特徵向量的輸出,該向量的每個元素對應於一個特徵通道。

這樣,GAP 產生了一個固定大小的特徵向量,該向量的大小獨立於輸入圖像的大小。因此最終並不需要使用到 flatten。直接輸出給 fully connected layer 即可。

> Increase Performance:

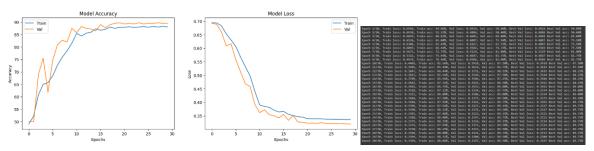


圖 10, 上圖為改 modle 前的表現情況, accuracy 卡在 88-89%之間就上不去了所以我更改了 layer 的層數, 在 model 中多增加了兩層的 layer 如下圖



圖 11,更改後的 model

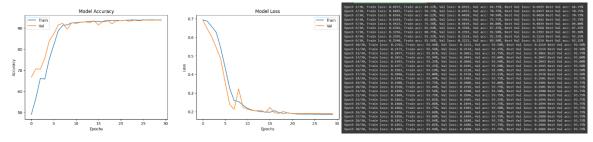


圖 12, train 和 validation 的 accuracy 都上升到了 93%左右。