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

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這次我是用 transfer learning 的方法進行分類的。

Swin_B_Weights.IMAGENET1K_V1:

These weights reproduce closely the results of the paper using a similar training recipe. Also available as `Swin_B_Weights.DEFAULT`.

acc@1 (on ImageNet-1K)	83.582
acc@5 (on ImageNet-1K)	96.64
categories	tench, goldfish, great white shark, ... (997 omitted)
num_params	87768224
min_size	height=224, width=224
recipe	link
GFLOPS	15.43
File size	335.4 MB

圖 1:此次使用的 pre train model

除此之外，為了防止出現 overfitting 的情況，我又多加入了 dropout 層避免 overfitting。

```
[37] import torch.nn as nn
     import torch.nn.functional as F
     from torchvision import models

     model = models.swin_b(weights='IMAGENET1K_V1')

     # # ConvNet as fixed feature extractor (freeze parameters)
     for param in model.parameters():
         param.requires_grad = False

     num_ftrs = model.head.in_features
     # Alternatively, it can be generalized to ``nn.Linear(num_ftrs, len(class_names))``.
     model.head = nn.Sequential(
         nn.Linear(num_ftrs, 256),
         nn.ReLU(),
         nn.Dropout(0.3),
         nn.Linear(256, 6)
     )
     model = model.cuda()
     print(model)
```
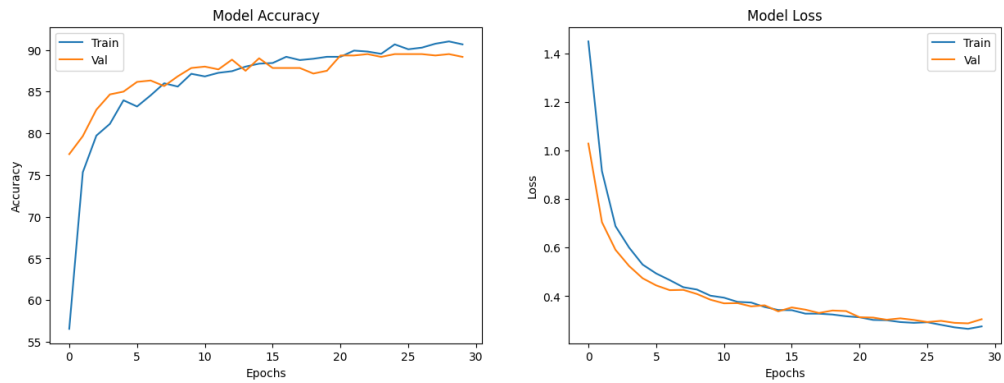
圖 2:本次的 model
- Dropout 0.3

圖 3:accuracy 與 loss 的表現。

```
100%  [████████████████████]  30/30 [14:38<00:00, 26.76s/it]
Epoch 1/30, Train loss: 1.4489, Train acc: 56.55%, Val loss: 1.0283, Val acc: 77.50%, Best Val loss: 1.0283 Best Val acc: 77.50%
Epoch 2/30, Train loss: 0.9152, Train acc: 75.33%, Val loss: 0.7047, Val acc: 79.67%, Best Val loss: 0.7047 Best Val acc: 79.67%
Epoch 3/30, Train loss: 0.6882, Train acc: 79.73%, Val loss: 0.5908, Val acc: 82.83%, Best Val loss: 0.5908 Best Val acc: 82.83%
Epoch 4/30, Train loss: 0.6004, Train acc: 81.14%, Val loss: 0.5245, Val acc: 84.67%, Best Val loss: 0.5245 Best Val acc: 84.67%
Epoch 5/30, Train loss: 0.5301, Train acc: 83.96%, Val loss: 0.4738, Val acc: 85.00%, Best Val loss: 0.4738 Best Val acc: 85.00%
Epoch 6/30, Train loss: 0.4935, Train acc: 83.22%, Val loss: 0.4444, Val acc: 86.17%, Best Val loss: 0.4444 Best Val acc: 86.17%
Epoch 7/30, Train loss: 0.4662, Train acc: 84.55%, Val loss: 0.4249, Val acc: 86.33%, Best Val loss: 0.4249 Best Val acc: 86.33%
Epoch 8/30, Train loss: 0.4370, Train acc: 86.00%, Val loss: 0.4260, Val acc: 85.67%, Best Val loss: 0.4249 Best Val acc: 86.33%
Epoch 9/30, Train loss: 0.4274, Train acc: 85.61%, Val loss: 0.4092, Val acc: 86.83%, Best Val loss: 0.4092 Best Val acc: 86.83%
Epoch 10/30, Train loss: 0.4021, Train acc: 87.14%, Val loss: 0.3855, Val acc: 87.83%, Best Val loss: 0.3855 Best Val acc: 87.83%
Epoch 11/30, Train loss: 0.3939, Train acc: 86.82%, Val loss: 0.3706, Val acc: 88.00%, Best Val loss: 0.3706 Best Val acc: 88.00%
Epoch 12/30, Train loss: 0.3766, Train acc: 87.25%, Val loss: 0.3714, Val acc: 87.67%, Best Val loss: 0.3706 Best Val acc: 88.00%
Epoch 13/30, Train loss: 0.3739, Train acc: 87.45%, Val loss: 0.3581, Val acc: 88.83%, Best Val loss: 0.3581 Best Val acc: 88.83%
Epoch 14/30, Train loss: 0.3555, Train acc: 88.00%, Val loss: 0.3624, Val acc: 87.50%, Best Val loss: 0.3581 Best Val acc: 88.83%
Epoch 15/30, Train loss: 0.3432, Train acc: 88.35%, Val loss: 0.3376, Val acc: 89.00%, Best Val loss: 0.3376 Best Val acc: 89.00%
Epoch 16/30, Train loss: 0.3424, Train acc: 88.43%, Val loss: 0.3537, Val acc: 87.83%, Best Val loss: 0.3376 Best Val acc: 89.00%
Epoch 17/30, Train loss: 0.3281, Train acc: 89.18%, Val loss: 0.3446, Val acc: 87.83%, Best Val loss: 0.3376 Best Val acc: 89.00%
Epoch 18/30, Train loss: 0.3280, Train acc: 88.78%, Val loss: 0.3309, Val acc: 87.83%, Best Val loss: 0.3309 Best Val acc: 89.00%
Epoch 19/30, Train loss: 0.3246, Train acc: 88.94%, Val loss: 0.3410, Val acc: 87.17%, Best Val loss: 0.3309 Best Val acc: 89.00%
Epoch 20/30, Train loss: 0.3175, Train acc: 89.18%, Val loss: 0.3387, Val acc: 87.50%, Best Val loss: 0.3309 Best Val acc: 89.00%
Epoch 21/30, Train loss: 0.3132, Train acc: 89.18%, Val loss: 0.3133, Val acc: 89.33%, Best Val loss: 0.3133 Best Val acc: 89.33%
Epoch 22/30, Train loss: 0.3023, Train acc: 89.92%, Val loss: 0.3119, Val acc: 89.33%, Best Val loss: 0.3119 Best Val acc: 89.33%
Epoch 23/30, Train loss: 0.3011, Train acc: 89.80%, Val loss: 0.3030, Val acc: 89.50%, Best Val loss: 0.3030 Best Val acc: 89.50%
Epoch 24/30, Train loss: 0.2935, Train acc: 89.53%, Val loss: 0.3089, Val acc: 89.17%, Best Val loss: 0.3030 Best Val acc: 89.50%
Epoch 25/30, Train loss: 0.2903, Train acc: 90.67%, Val loss: 0.3022, Val acc: 89.50%, Best Val loss: 0.3022 Best Val acc: 89.50%
Epoch 26/30, Train loss: 0.2928, Train acc: 90.08%, Val loss: 0.2936, Val acc: 89.50%, Best Val loss: 0.2936 Best Val acc: 89.50%
Epoch 27/30, Train loss: 0.2821, Train acc: 90.27%, Val loss: 0.2984, Val acc: 89.50%, Best Val loss: 0.2936 Best Val acc: 89.50%
Epoch 28/30, Train loss: 0.2717, Train acc: 90.75%, Val loss: 0.2902, Val acc: 89.33%, Best Val loss: 0.2902 Best Val acc: 89.50%
Epoch 29/30, Train loss: 0.2655, Train acc: 91.02%, Val loss: 0.2882, Val acc: 89.50%, Best Val loss: 0.2882 Best Val acc: 89.50%
Epoch 30/30, Train loss: 0.2756, Train acc: 90.67%, Val loss: 0.3051, Val acc: 89.17%, Best Val loss: 0.2882 Best Val acc: 89.50%
```

圖 4:進行 30 個 epoch 的表現。\

- Dropout 0.2

```
100%|████████████████████████████████| 30/30 [14:22<00:00, 27.56s/it]
Epoch 1/30, Train loss: 1.4311, Train acc: 59.37%, Val loss: 1.0258, Val acc: 75.33%, Best Val loss: 1.0258 Best Val acc: 75.33%
Epoch 2/30, Train loss: 0.8832, Train acc: 76.20%, Val loss: 0.6977, Val acc: 78.67%, Best Val loss: 0.6977 Best Val acc: 78.67%
Epoch 3/30, Train loss: 0.6735, Train acc: 80.00%, Val loss: 0.5760, Val acc: 82.33%, Best Val loss: 0.5760 Best Val acc: 82.33%
Epoch 4/30, Train loss: 0.5752, Train acc: 82.55%, Val loss: 0.5261, Val acc: 83.33%, Best Val loss: 0.5261 Best Val acc: 83.33%
Epoch 5/30, Train loss: 0.5031, Train acc: 84.63%, Val loss: 0.4734, Val acc: 83.83%, Best Val loss: 0.4734 Best Val acc: 83.83%
Epoch 6/30, Train loss: 0.4848, Train acc: 83.92%, Val loss: 0.4434, Val acc: 84.83%, Best Val loss: 0.4434 Best Val acc: 84.83%
Epoch 7/30, Train loss: 0.4481, Train acc: 85.61%, Val loss: 0.4300, Val acc: 86.00%, Best Val loss: 0.4300 Best Val acc: 86.00%
Epoch 8/30, Train loss: 0.4292, Train acc: 86.04%, Val loss: 0.4123, Val acc: 86.00%, Best Val loss: 0.4123 Best Val acc: 86.00%
Epoch 9/30, Train loss: 0.4112, Train acc: 86.67%, Val loss: 0.3876, Val acc: 88.00%, Best Val loss: 0.3876 Best Val acc: 88.00%
Epoch 10/30, Train loss: 0.3860, Train acc: 87.02%, Val loss: 0.3717, Val acc: 87.83%, Best Val loss: 0.3717 Best Val acc: 88.00%
Epoch 11/30, Train loss: 0.3719, Train acc: 87.18%, Val loss: 0.3822, Val acc: 86.50%, Best Val loss: 0.3717 Best Val acc: 88.00%
Epoch 12/30, Train loss: 0.3635, Train acc: 87.88%, Val loss: 0.3541, Val acc: 88.50%, Best Val loss: 0.3541 Best Val acc: 88.50%
Epoch 13/30, Train loss: 0.3500, Train acc: 88.12%, Val loss: 0.3487, Val acc: 88.17%, Best Val loss: 0.3487 Best Val acc: 88.50%
Epoch 14/30, Train loss: 0.3518, Train acc: 87.88%, Val loss: 0.3585, Val acc: 88.00%, Best Val loss: 0.3487 Best Val acc: 88.50%
Epoch 15/30, Train loss: 0.3366, Train acc: 88.51%, Val loss: 0.3342, Val acc: 88.50%, Best Val loss: 0.3342 Best Val acc: 88.50%
Epoch 16/30, Train loss: 0.3312, Train acc: 89.10%, Val loss: 0.3262, Val acc: 89.33%, Best Val loss: 0.3262 Best Val acc: 89.33%
Epoch 17/30, Train loss: 0.3320, Train acc: 89.06%, Val loss: 0.3309, Val acc: 88.83%, Best Val loss: 0.3262 Best Val acc: 89.33%
Epoch 18/30, Train loss: 0.3198, Train acc: 88.90%, Val loss: 0.3258, Val acc: 88.67%, Best Val loss: 0.3258 Best Val acc: 89.33%
Epoch 19/30, Train loss: 0.3098, Train acc: 89.96%, Val loss: 0.3297, Val acc: 88.17%, Best Val loss: 0.3258 Best Val acc: 89.33%
Epoch 20/30, Train loss: 0.2906, Train acc: 90.51%, Val loss: 0.3172, Val acc: 89.17%, Best Val loss: 0.3172 Best Val acc: 89.33%
Epoch 21/30, Train loss: 0.2978, Train acc: 89.76%, Val loss: 0.3129, Val acc: 88.83%, Best Val loss: 0.3129 Best Val acc: 89.33%
Epoch 22/30, Train loss: 0.2905, Train acc: 90.24%, Val loss: 0.3238, Val acc: 88.50%, Best Val loss: 0.3129 Best Val acc: 89.33%
Epoch 23/30, Train loss: 0.2971, Train acc: 89.57%, Val loss: 0.3054, Val acc: 89.17%, Best Val loss: 0.3054 Best Val acc: 89.33%
Epoch 24/30, Train loss: 0.2846, Train acc: 90.71%, Val loss: 0.3187, Val acc: 89.17%, Best Val loss: 0.3054 Best Val acc: 89.33%
Epoch 25/30, Train loss: 0.2898, Train acc: 90.43%, Val loss: 0.2985, Val acc: 89.33%, Best Val loss: 0.2985 Best Val acc: 89.33%
Epoch 26/30, Train loss: 0.2798, Train acc: 90.67%, Val loss: 0.2996, Val acc: 89.17%, Best Val loss: 0.2985 Best Val acc: 89.33%
Epoch 27/30, Train loss: 0.2796, Train acc: 90.39%, Val loss: 0.2941, Val acc: 89.67%, Best Val loss: 0.2941 Best Val acc: 89.67%
Epoch 28/30, Train loss: 0.2611, Train acc: 90.90%, Val loss: 0.2947, Val acc: 89.50%, Best Val loss: 0.2941 Best Val acc: 89.67%
Epoch 29/30, Train loss: 0.2717, Train acc: 90.55%, Val loss: 0.3020, Val acc: 89.33%, Best Val loss: 0.2941 Best Val acc: 89.67%
Epoch 30/30, Train loss: 0.2573, Train acc: 91.02%, Val loss: 0.2987, Val acc: 89.17%, Best Val loss: 0.2941 Best Val acc: 89.67%
```


Model Accuracy   Model Loss
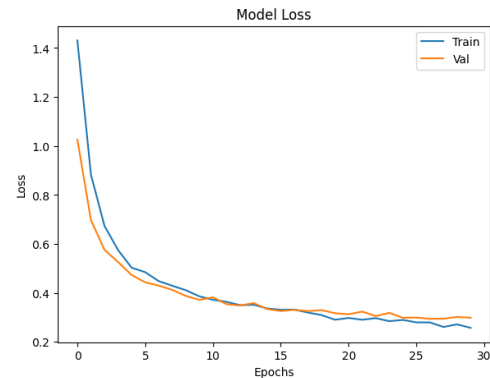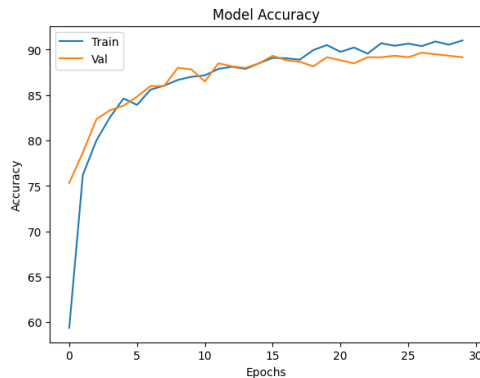
- Dropout 0.1

```
100%|████████████████████████████████| 30/30 [14:01<00:00, 28.64s/it]
Epoch 1/30, Train loss: 0.6923, Train acc: 80.20%, Val loss: 0.5921, Val acc: 81.50%, Best Val loss: 0.5921 Best Val acc: 81.50%
Epoch 2/30, Train loss: 0.5781, Train acc: 82.55%, Val loss: 0.5178, Val acc: 83.00%, Best Val loss: 0.5178 Best Val acc: 83.00%
Epoch 3/30, Train loss: 0.5093, Train acc: 83.61%, Val loss: 0.4709, Val acc: 84.00%, Best Val loss: 0.4709 Best Val acc: 84.00%
Epoch 4/30, Train loss: 0.4757, Train acc: 84.47%, Val loss: 0.4432, Val acc: 85.00%, Best Val loss: 0.4432 Best Val acc: 85.00%
Epoch 5/30, Train loss: 0.4349, Train acc: 85.45%, Val loss: 0.4229, Val acc: 86.50%, Best Val loss: 0.4229 Best Val acc: 86.50%
Epoch 6/30, Train loss: 0.4099, Train acc: 86.94%, Val loss: 0.3919, Val acc: 87.83%, Best Val loss: 0.3919 Best Val acc: 87.83%
Epoch 7/30, Train loss: 0.3817, Train acc: 87.76%, Val loss: 0.3795, Val acc: 88.00%, Best Val loss: 0.3795 Best Val acc: 88.00%
Epoch 8/30, Train loss: 0.3698, Train acc: 88.08%, Val loss: 0.3696, Val acc: 87.83%, Best Val loss: 0.3696 Best Val acc: 88.00%
Epoch 9/30, Train loss: 0.3537, Train acc: 88.71%, Val loss: 0.3703, Val acc: 87.67%, Best Val loss: 0.3696 Best Val acc: 88.00%
Epoch 10/30, Train loss: 0.3478, Train acc: 88.08%, Val loss: 0.3532, Val acc: 88.33%, Best Val loss: 0.3532 Best Val acc: 88.33%
Epoch 11/30, Train loss: 0.3474, Train acc: 88.31%, Val loss: 0.3373, Val acc: 88.50%, Best Val loss: 0.3373 Best Val acc: 88.50%
Epoch 12/30, Train loss: 0.3321, Train acc: 88.39%, Val loss: 0.3496, Val acc: 87.67%, Best Val loss: 0.3373 Best Val acc: 88.50%
Epoch 13/30, Train loss: 0.3199, Train acc: 88.78%, Val loss: 0.3492, Val acc: 88.17%, Best Val loss: 0.3373 Best Val acc: 88.50%
Epoch 14/30, Train loss: 0.3171, Train acc: 89.53%, Val loss: 0.3243, Val acc: 88.67%, Best Val loss: 0.3243 Best Val acc: 88.67%
Epoch 15/30, Train loss: 0.3037, Train acc: 89.76%, Val loss: 0.3284, Val acc: 89.17%, Best Val loss: 0.3243 Best Val acc: 89.17%
Epoch 16/30, Train loss: 0.2996, Train acc: 89.84%, Val loss: 0.3276, Val acc: 89.17%, Best Val loss: 0.3243 Best Val acc: 89.17%
Epoch 17/30, Train loss: 0.3014, Train acc: 90.12%, Val loss: 0.3235, Val acc: 88.50%, Best Val loss: 0.3235 Best Val acc: 89.17%
Epoch 18/30, Train loss: 0.2948, Train acc: 89.88%, Val loss: 0.3082, Val acc: 89.50%, Best Val loss: 0.3082 Best Val acc: 89.50%
Epoch 19/30, Train loss: 0.2907, Train acc: 90.43%, Val loss: 0.3147, Val acc: 89.33%, Best Val loss: 0.3082 Best Val acc: 89.50%
Epoch 20/30, Train loss: 0.2867, Train acc: 90.59%, Val loss: 0.3219, Val acc: 88.50%, Best Val loss: 0.3082 Best Val acc: 89.50%
Epoch 21/30, Train loss: 0.2769, Train acc: 90.71%, Val loss: 0.3022, Val acc: 89.33%, Best Val loss: 0.3022 Best Val acc: 89.50%
Epoch 22/30, Train loss: 0.2736, Train acc: 90.47%, Val loss: 0.2935, Val acc: 89.50%, Best Val loss: 0.2935 Best Val acc: 89.50%
Epoch 23/30, Train loss: 0.2687, Train acc: 90.51%, Val loss: 0.2919, Val acc: 89.50%, Best Val loss: 0.2919 Best Val acc: 89.50%
Epoch 24/30, Train loss: 0.2681, Train acc: 90.75%, Val loss: 0.2943, Val acc: 89.17%, Best Val loss: 0.2919 Best Val acc: 89.50%
Epoch 25/30, Train loss: 0.2605, Train acc: 90.75%, Val loss: 0.2941, Val acc: 89.33%, Best Val loss: 0.2919 Best Val acc: 89.50%
Epoch 26/30, Train loss: 0.2564, Train acc: 91.45%, Val loss: 0.2917, Val acc: 89.67%, Best Val loss: 0.2917 Best Val acc: 89.67%
Epoch 27/30, Train loss: 0.2608, Train acc: 91.92%, Val loss: 0.2925, Val acc: 89.50%, Best Val loss: 0.2917 Best Val acc: 89.67%
Epoch 28/30, Train loss: 0.2449, Train acc: 92.43%, Val loss: 0.2839, Val acc: 89.83%, Best Val loss: 0.2839 Best Val acc: 89.83%
Epoch 29/30, Train loss: 0.2450, Train acc: 91.96%, Val loss: 0.2917, Val acc: 89.00%, Best Val loss: 0.2839 Best Val acc: 89.83%
Epoch 30/30, Train loss: 0.2349, Train acc: 91.96%, Val loss: 0.2872, Val acc: 90.00%, Best Val loss: 0.2839 Best Val acc: 90.00%
```
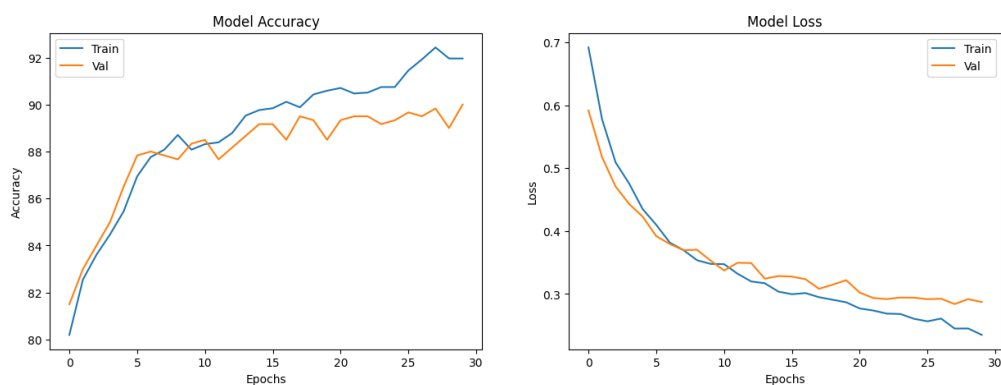
最終選擇 dropout 為 0.1 進行 evaluate，因為從 loss 來看 dropout 為 0.1 最小，並且在進行 validation data 測試的時候分數也是最高的。

最終 test 的結果為 accuracy 為 92%

```
                images  =  images.cuda()
                images  =  images  /  255.

                labels  =  labels.cuda()
                labels  =  labels.long()

                outputs  =  model(images)

                predicted  =  outputs.argmax(-1)
                test_correct  +=  (predicted.float()  ==  labels).sum().item()
                test_total  +=  labels.size(0)

    print(f'Test  accuracy  is  {100.  *  test_correct  /  test_total}%')

    Test accuracy is 92.16666666666667%
```