2023 Fall MIP - Final Project Report

生醫電資所 碩一 R12945040 郭思言

題目：Implementing Breast Ultrasound Cancer Tumor Segmentation with UNet++

題目發想：

在這學期的期中作業中，老師提供了一個超音波影像供我們做segmentation。在作業中，我使用了MeVislab中的Region Growing以及Fuzzy Connected Distance兩個方法，並沒有使用深度學習的方法來做。因此我想說是否可以找網路上開源的超音波影像（腫瘤）資料集來訓練一個深度學習模型，看看訓練的結果，並在最後嘗試inference在老師提供的那張超音波影像上看看結果如何。

Material and Methods

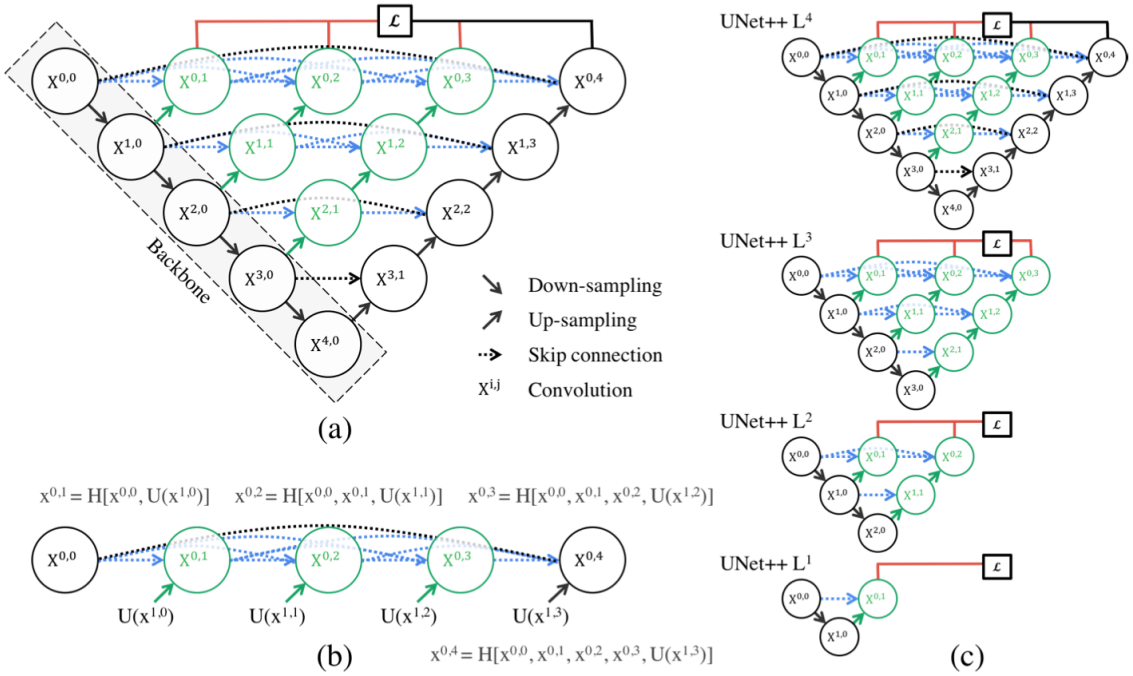
這次project我選擇使用UNet++來作為我的Model，因位先前有使用過最陽春的UNet，這次想看看改進後同樣也在醫學影像領域有不錯成效的UNet++效果如何。UNet++相比UNet，在原來的skip connection部分接入了更多的連階層，作者是提到這樣子增加上下層的交流可以訓練到更多的細節部分。

我的dataset是選擇使用在Kaggle上有公開的BUS Synthetic Dataset。選擇這個是因為在網路上搜尋了超音波的腫瘤資料集，這個資料集看起來非常接近老師提供的out_112.bmp影像。想說如果利用這個訓練模型，預測out_112.bmp的腫瘤應該較能有不錯的結果。

- Model:

  UNet++: A Nested U-Net Architecture for Medical Image Segmentation

  - Paper link: https://arxiv.org/abs/1807.10165
  - Github: https://github.com/4uiiurz1/pytorch-nested-unet



- Dataset:

  BUS Synthetic Dataset (Breast Ultrasound synthetic images 2023)

  - Dataset link: https://www.kaggle.com/datasets/jocelyndumlao/bus-synthetic-dataset
  - Contains 500 BUS synthetic images and corresponding masks with 128×128 resolution
  - Randomly splits the dataset into 8:2 training and validation data
- Hyperparameters
  - batch size: 16
  - learning rate: 0.001
  - max epoch: 1000
  - loss: BCEDiceLoss
  - optimizer: SGD
- Environments
  - albumentations==1.3.1

- numpy==1.26.2
- opencv_python_headless==4.8.1.78
- pandas==2.1.3
- PyYAML==6.0.1
- scikit_learn==1.3.2
- torch==2.1.1
- tqdm==4.66.1

Usage

- Install environmental packages:

  `conda create -n <env_name> python=3.9`

  `conda activate <env_name>`

  `pip install -r requirements.txt`

- Training

  `python train.py --dataset BUS_synthetic_dataset --arch NestedUNet --img_ext .png --mask_ext .png --epoch 1000`

- Validation

  `python val.py --name BUS_synthetic_dataset_NestedUNet_woDS`

- Inference on the out_112.bmp image

  `python inference.py --name BUS_synthetic_dataset_NestedUNet_woDS`

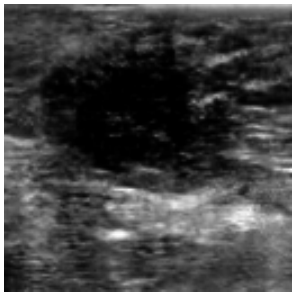
  → **pred_mask_112.bmp** and **overlay_112.bmp** is saved in the ./images file

Results

- Results on the validation data of the BUS dataset
  - IoU: 0.9021

```
=> creating model NestedUNet
100%|                                                  | 7/7 [00:00<00:00,  7.19it/s]
IoU: 0.9021
```

  - some examples of the validation images



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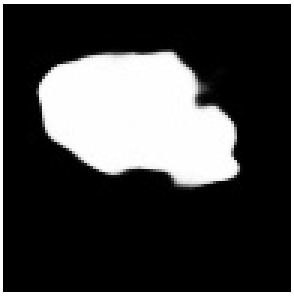
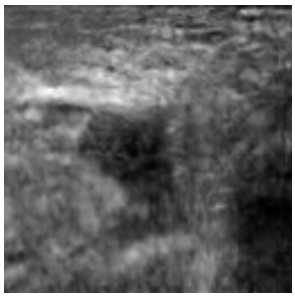


pred. mask

ground truth



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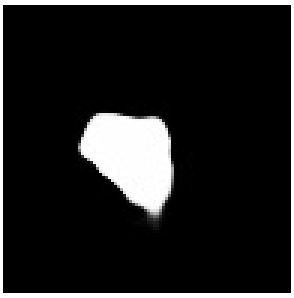
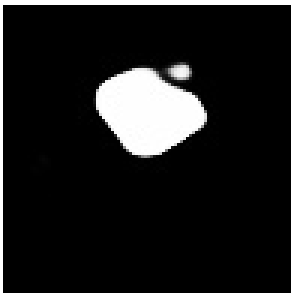


pred. mask

ground truth

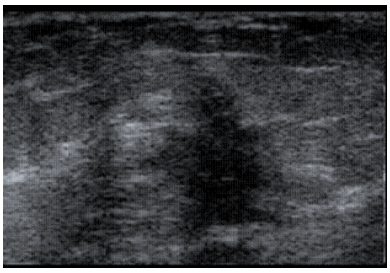
490111



pred. mask

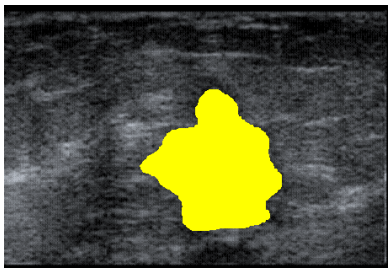
ground truth

- Results on out_112.bmp



out_112.bmp

pred. mask



overlay

Discussion

看起來UNet++效果不錯，訓練時間不長，而且在validation dataset上能夠達到0.9021的IoU。

最終測試在out_112.bmp上，可以看到應該是有準確地將腫瘤區域切割出來。

Citation

- UNet++: A Nested U-Net Architecture for Medical Image Segmentation https://arxiv.org/abs/1807.10165
- **Ahmed Iqbal, Muhammad Sharif**, "PDF-UNet: A semi-supervised method for segmentation of breast tumor images using a U-shaped pyramid-dilated network", Expert Systems with Applications, 2023. https://doi.org/10.1016/j.eswa.2023.119718