SINGAPORE INSTITUTE OF TECHNOLOGY

School of Infocomm Technology

Applied Artificial Intelligence, BSc (Hons)

AAI3001 Computer Vision and Deep Learning

Main Project

Team Members	Student ID
LEO EN QI VALERIE	2202795
TEO XUANTING	2202217
TIAN YUE XIAO, BRYON	2201615

Date: 1 December 2023

GitHub Repository Link: https://github.com/Valdarie/AAI3001/

Submitted as part of the requirement for AAI3001 Computer Vision & Deep Learning

ALEXANDER BINDER, DR. RER. NAT.

1. Introduction

The purpose of the project focuses on Semantic Segmentation using the MoNuSeg dataset to fine-tune a model that is capable of accurately categorising various tissue types within medical images. The methodology includes essential steps such as data splitting, model fine-tuning, and a thorough assessment procedure. This method provides a more complex understanding of the model's performance in defining vulnerable aspects in the medical imagery scene.

2. Technical Setup

Please run train.py first, val.py, and test.py accordingly.

PROJECT PATH DIRECTORY

```
root_folder/
|--model/
|        |--uNet.py
|--monusegData/
|        |--testData/
|        |        |--TCGA-2Z-A9J9-01A-01-TS1.tif
|        |        |--TCGA-2Z-A9J9-01A-01-TS1.xml
|        |        |--TCGA-44-2665-01B-06-BS6.tif
|        |        |--TCGA-44-2665-01B-06-BS6.xml
|        |        |--. . .
|        |--testMask/
|        |        |--TCGA-2Z-A9J9-01A-01-TS1.png
|        |        |--TCGA-44-2665-01B-06-BS6.png
|        |        |--TCGA-69-7764-01A-01-TS1.png
|        |        |--. . .
|        |--trainData/
|        |        |--Annotations/
|        |        |        |--TCGA-18-5592-01Z-00-DX1.xml
|        |        |        |--TCGA-21-5784-01Z-00-DX1.xml
|        |        |        |--. . .
|        |        |--tissueimages/
|        |        |        |--TCGA-18-5592-01Z-00-DX1.tif
|        |        |        |--TCGA-21-5784-01Z-00-DX1.tif
|        |        |        |--. . .
|        |        |--.DS_Store
|        |--trainMask/
|        |        |--TCGA-18-5592-01Z-00-DX1.png
|        |        |--TCGA-21-5784-01Z-00-DX1.png
|        |        |--TCGA-21-5786-01Z-00-DX1.png
|        |        |--. . .
|        |--valMask/
|        |        |--TCGA-49-4488-01Z-00-DX1.png
|        |        |--TCGA-A7-A13E-01Z-00-DX1.png
|        |        |--TCGA-B0-5711-01Z-00-DX1.png
|        |        |--. . .
|--utils/
|        |--customDataset.py
|        |--imageMasker.py
|        |--metrics.py
|--test.py
|--test_images.json
|--train.py
|--train_images.json
|--trained_unet_model.pth
|--val.py
|--val_images.json
```

Figure 1.0 GitHub project path directory

3. Data Processing

Before training the model, the data has to be split into their respective categories. train.py is used for training the model and val.py is used for validating the results of the model's prediction.

PREPROCESSING PARAMETERS	TRAIN-TEST SPLIT
Training data:	80%
Validation data:	20%

4. Training Experimental Parameters & Procedures

Below are the parameters used for training the model:

TRAINING PARAMETERS	VALUES
Random Seed:	42
Batch Size:	4
Learning Rate:	0.001
Number of Epochs:	3
Optimiser:	Adam
Loss Function:	BCEWithLogitsLoss

In addition, there is also data augmentation onto the training dataset to provide more diversity to the training. RandomHorizontalFlip, RandomVerticalFlip, RandomRotation and ColorJitter were introduced to add variations and to augment the dataset thereby promoting a more robust and versatile training process.

DATA AUGMENTATION	VALUES
RandomHorizontalFlip	0
RandomVerticalFlip	0
RandomRotation	30 degrees
ColorJitter	brightness=0.2, contrast=0.2, saturation=0.2, hue=0.2

5. Model Architecture

Utilising the U-Net Model Architecture, our Semantic Segmentation approach on the MoNuSeg dataset benefits from its precision in delineating fine-grained structures, effective feature fusion, adaptability to diverse tissue patterns via hierarchical structures and flexibility to handle varying image resolutions. The semantic segmentation project uses an UNet architecture with a specific configuration: n_channels=3 and n_classes=1. This setup is tailored for processing RGB images in binary segmentation tasks. UNet's U-shaped architecture enables the effective capture of high and low-level features, making it well-suited for detailed semantic segmentation.

6. Training and Validation Results

After training the model through all epochs, the script will generate the training and validation results and provide a visual of the Original Image, Predicted Mask and True Mask to view the models progression.

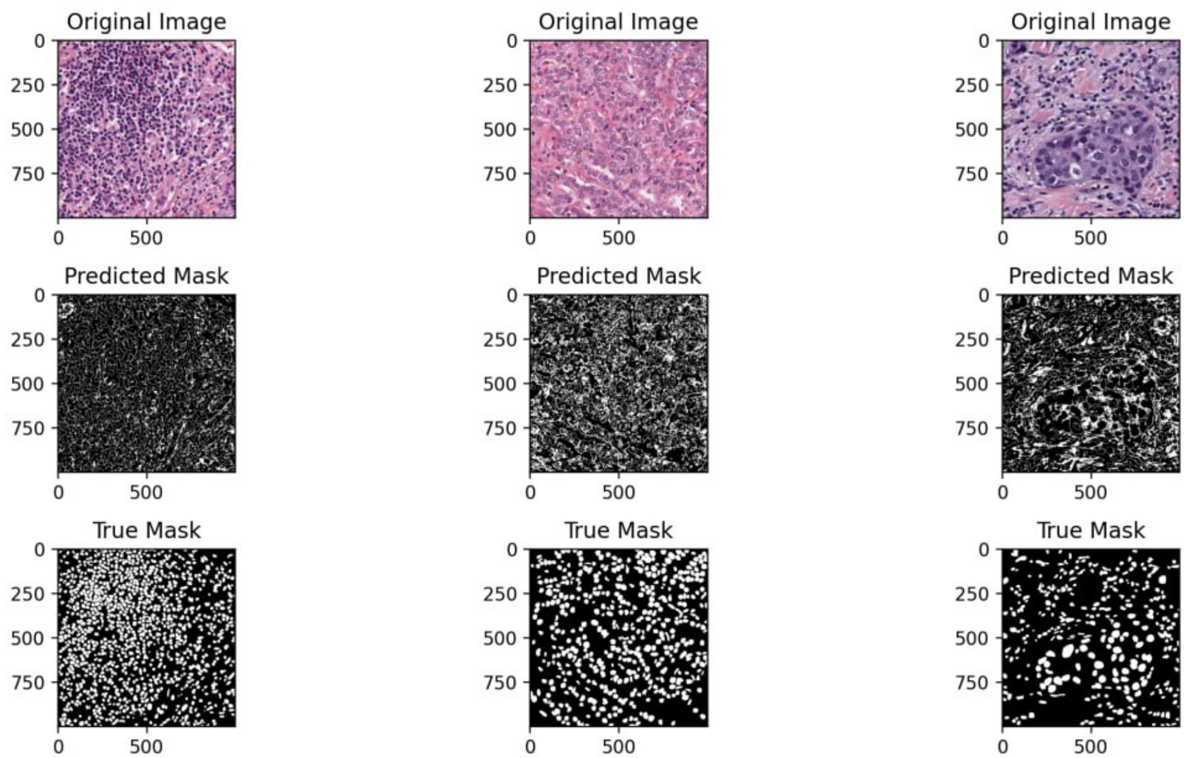

Figure 2.0 Training and Validation Results

7. Performance Measurement and Evaluation

1st Category Evaluation: mIoU

Description

The formula for mean Intersection Over Union (mIoU) are as shown below:

$$mIoU = \frac{1}{N_{class}} \sum_{i=1}^{N_{class}} \frac{TP(i)}{TP(i)+FP(i)+FN(i)}$$

Whereby

TP: $True\ Positive$

FP: $False\ Positive$

TN: $True\ Negative$

FN: $False\ Negative$

Results

```
The train, validation, and test sets are disjoint.
Epoch 1/3, Train Loss: 0.6706, Train IoU: 0.1904, Val Loss: 0.7176, Val IoU: 0.2530
Epoch 2/3, Train Loss: 0.6343, Train IoU: 0.1434, Val Loss: 0.6888, Val IoU: 0.2183
Epoch 3/3, Train Loss: 0.6198, Train IoU: 0.0397, Val Loss: 0.6362, Val IoU: 0.0005
```

- **Train Loss:** The average loss computed for the training data in each epoch. Lower values indicate better fit.
- **Train IoU:** The Intersection over Union (IoU) for the training data in each epoch. This metric measures the overlap between the predicted and true labels. Higher values indicate better segmentation.
- **Val Loss:** The average loss computed for the validation data in each epoch. Lower values indicate better fit.
- **Val IoU:** The Intersection over Union (IoU) for the validation data in each epoch. This metric measures the overlap between the predicted and true labels. Higher values indicate better segmentation.

By observing the output, we can make the following observations:

The training loss is decreasing from Epoch 1 to Epoch 3, which is expected as the model is learning and improving over time. The training IoU is not increasing, indicating that the model is having difficulties segmenting the training data. This could be due to a number of reasons, such as overfitting or underfitting, or a poorly designed model. The validation loss is decreasing from Epoch 1 to Epoch 3, which suggests the model is generalising better as it trains.The validation IoU is not increasing, which could be a sign of underfitting, or a problem with the validation data.

2nd Category Evaluation: We have tried but failed :(

Please spare thoughts for struggling AI students thank you :)