[CS-8395 Spring 20] Deep Learning in Medical Image Computing

Assignment 3: Segmentation

I. Purpose:

This homework contains a 3D segmentation task for abdominal organs:

1. Develop a 2D/3D deep segmentation neural network on spleen segmentation.
2. You will use 30 CT volumes as training, and 20 CT volumes as testing.
3. Understand the basic metrics for classification (Dice).
4. Have the processing pipeline for the following assignments.

The training data is large-scale, please use GPU since CPU is probably too slow.

II. Grading and Submission

1. The assignment will be evaluated in a total of 150 scores. The basic scores are generally given based on the following table. Then, the scores will be further adjusted based on requirements in "Tasks" (as red color scores in Tasks).

	Basic Score	**(score can be adjusted based on the "Task" requirements)**
Amazing Work	150	Design a new network with mean Dice=0.95 accuracy on 20 testing volumes.
	140	Have substantial improvements on an existing network with mean Dice=0.92 accuracy on 20 testing volumes.
Solid Project	130	Some improvements or directly using an existing network with mean Dice=0.8 accuracy on 20 testing volumes.
	120	Some improvements or directly using an existing network with at least mean Dice=0.7 accuracy on 20 testing volumes.
Significant Efforts	110	Some improvements or directly using an existing network with no roughly correct predictions on testing images.
Much Work Needed	90	Propose a method with some implementation.
Show Understanding	70	Propose a method without implementation.
Turn in Something	50	Barely written report.
No Turn in	0	

2. The assignment should be submitted in four formats:
   i) Presentations should be submitted to brightspace as a ppt/pptx file with last name and VUID (e.g., "Huo_huoy1.pptx").
   ii) A single PDF report file should be submitted to brightspace with last name and VUID (e.g., "Huo_huoy1.pdf"). The PDF report consist presentation slides and code. (**Please do not write any extra words**)
   iii) The same PDF file should also be printed (color/black) and please bring it to class. Don't forget to put your name and VUID on the first page of the report.
   iv) All source code should be submitted to brightspace as a single zip file with last name and VUID (e.g., "Huo_huoy1.zip").

3. The deadline of braightspace submission is 9:00am on March 17th.
   The deadline of hardcopy report is 4:00pm on March 17th.

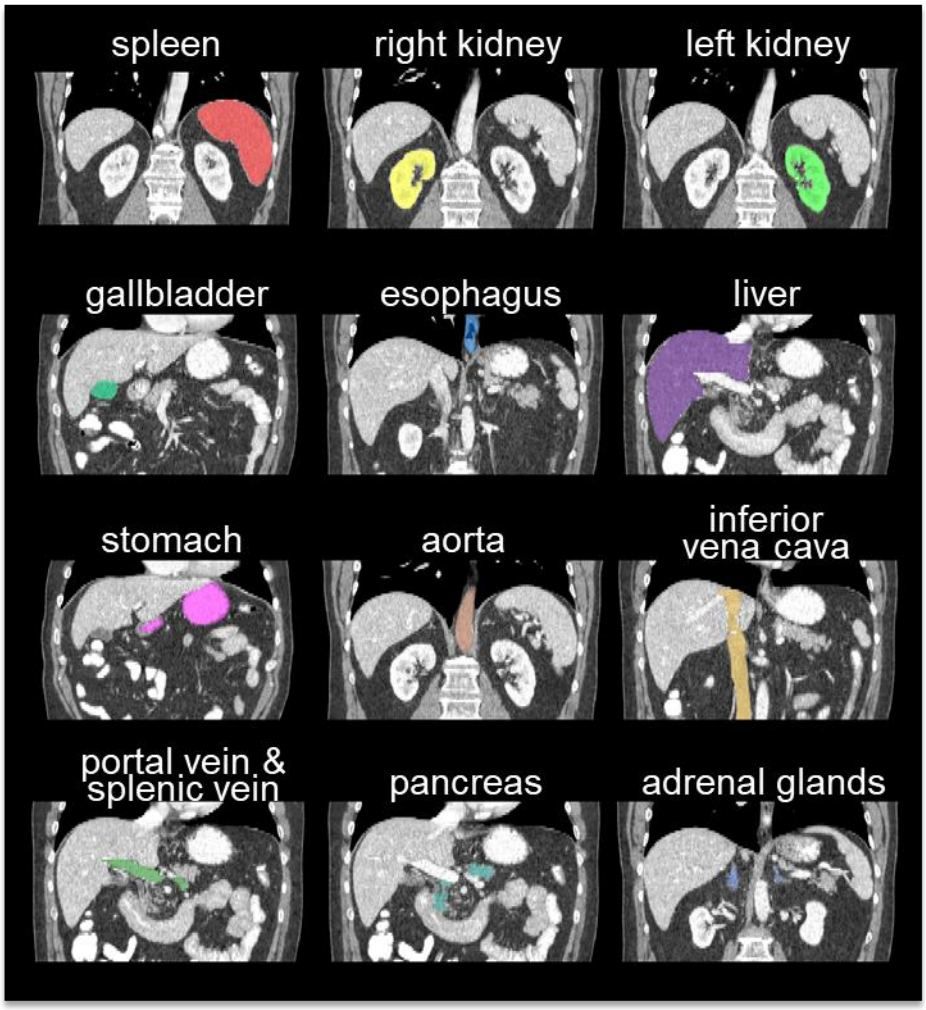
III. Description

This assignment is to implement a classification deep neural network. The link for downloading the data is provided in BrightSpace.

1. 30 training CT volumes ("img") and the corresponding label volumes ("label") are saved in "Training" folder.
2. 20 testing CT volumes ("img") are saved in "Testing" folder.
3. The labels for 20 testing volumes are not released so that instructor will calculate the Dice.

Everything about the data can be found from "Multi-Atlas Labeling Beyond the Cranial Vault" website (https://www.synapse.org/#!Synapse:syn3193805/wiki/89480)

- You only need to do Spleen segmentation, whose label = 1.
- You are free to use 2D or 3D networks.
- You must submit 20 segmentation volumes for testing scans.



The labels for train volumes are provided. You can tune the network base on train volumes to obtain the good combinations of hyper-parameters (learning rate, batch size etc.) using leave-n-out validation. The main training code should be named as “train.py”. More than 10 labels (organs) are provided in the training data, but only spleen (label=1) will be evaluated by lecture.

IV. Tasks:

The following tasks can be run on Windows, Mac or Linux, with/without GPU.

1. Presentation

   Each presentation is presented in 3 minutes. Less than 3 is totally fine, but please try to keep in within 3 minutes. (10 scores)

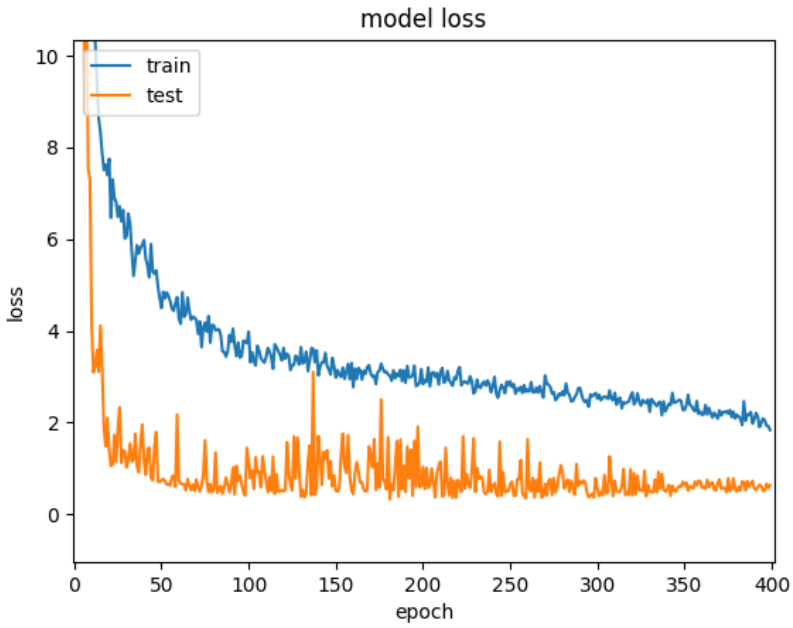
   i) Title page with name, 1 slide. (5 scores)

   ii) Introduction, 1 slide, (5 scores)
   Summarize the task in 1 slide.

   iii) Rationale, 1-2 slides (10 scores)
   The method you referred and why did you use that.

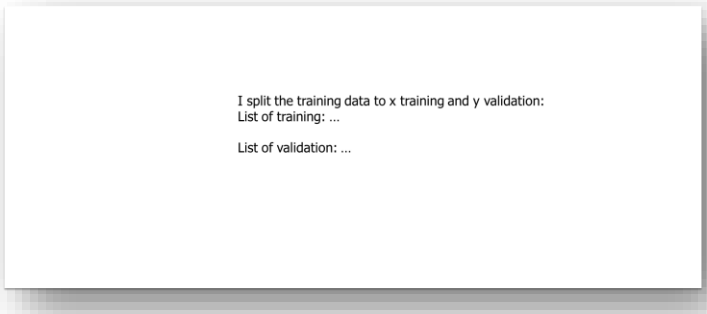
   iv) Method, 2 slides (20 scores)
   Slide 1:
   Show a figure of network structure. If you use existing networks (e.g. ResNet, VGG, AlexNet etc.), you can even copy paste the figure from google/paper. The purpose of the figure is to let the reader understand the method quickly.
   Slide 2:
   Show how did your format the input and output?
   Slide 3:
   Show did you use any interesting tricks for training? (e.g., preprocessing, postprocessing, data augmentation etc.)
   Slide 4:
   Describe the hyper parameters used during training. (e.g., epoch number, batch size, learning rate, loss function, parameters of layers, optimizer, input number of channels, output number of channels, OS, GPU/CPU model).

   v) Results on leave-n-out validation, 3 slides (20 scores)
   Slide 1:
   One figure shows training and testing loss along with epochs, such as the following example figure.



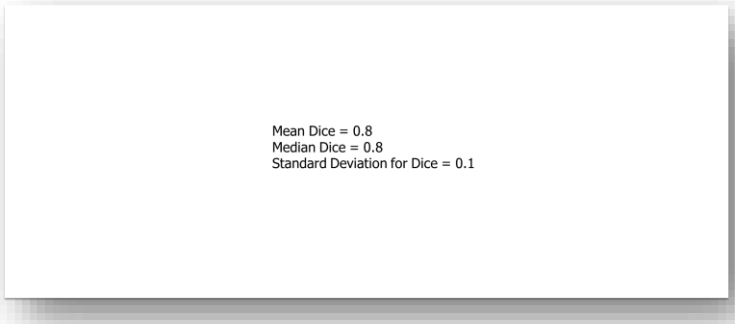
Slide 2:

One slide shows how did you do leave-n-out validation.



Slide 3:

One figure shows mean, median, and standard deviation of Dice



You can decide if you will present your results slides or not during in class presentation.

vi) Conclusion, 1-2 slides (10 scores)
Summarize the experiments (e.g., difficulties, limitations, or thoughts).

2. Code

Paste your code at the end of the report and submitted the e-version as a zip file. The consistency of the method, results and the code would be evaluated by lecturer.

i) Code for training (10 scores)
The labels for 30 training are provided. You can tune the network base on train volumes using leave-n-out validation to obtain the good combinations of hyper-parameters (learning rate, batch size etc.). The main training code should be named as "train.py".

3. Submission (50 scores), very important!

Submit report in both e-version and hardcopy.
Submit code in e-version.
Submit presentation in e-version.
Submit your segmentation results as nifty format files (in original space and resolution) in a single folder called "Segmentation". Please name the files EXACTLY as following format, like "label0061.nii.gz", for the lecturer to calculate Dice. For each segmentation file, spleen need to be assigned as label = 1.