Deep learning Cardiac Cine MRI Segmentation

Assignments

May, 2025

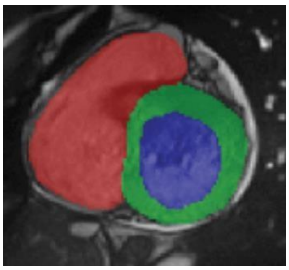
Deadline: Presentation, June 4th; Report, June 8th

Your report should include answers to all the questions. Please comment and clearly justify your answers. The Python code and report need to be **uploaded to the Blackboard** system before the deadline. You need to submit: 1) All the **Python files** that you have generated and 2) A **report**, in pdf with the obtained figures, answers and detailed comments. Failure to submit code will result in a **40% reduction** of the assignment mark and 3) Your presentation slides. **Only one group member is needed to submit the files. Remember to list the names (in Chinese) of all group members in the report.**

Detailed tasks for the first project can be found in the "Deep cardiac image segmentation project-2025.pdf" in the zip file.
Basically, there is a total of **30 marks** for this project report. However, **5 additional marks** can be gained if you could do the extra task (the last one).
The deadline for this project is **June 4th**. **You are supposed to give a presentation of this project on that day, which will count for another 15 marks.**

Provided Material

- **cine_seg. npz** The cardiac cine images and the corresponding segmentation labels for left ventricle (LV), right ventricle (RV) and the myocardium (MYO). In the following example segmentation, blue is for LV; green is for MYO; red is for RV.



- The training samples were created from the public ACDC cardiac dataset (https://www.creatis.insa-lyon.fr/Challenge/acdc/databases.html).

Assignment

(a) ***(10 marks)*** Split the cine dataset into training, validation and testing with a ratio of 4:1:2. Design your own U-Net for the segmentation task. The key network parameters include the number of channels in the first stage and the number of downsampling stages in the encoder. You should use **the cross-entropy loss** in this task. Plot your training loss and validation loss. Show example segmentation results. Calculate the **Dice coefficients** of LV, RV and MYO for all testing slices and report the mean and standard deviation of the Dice metrics. Then, comment on the segmentation performance of RV, LV and MYO, respectively. You may use the cross-entropy and Dice coefficient calculation functions that you have implemented in the demo class.

(b) ***(5 marks)*** Remove the short-cut connection in the UNet and retrain the abated UNet following the same procedure of training the UNet in step (a). Compare the segmentation performance (Dice coefficient) of the two networks and explain what causes the performance difference.

(c) ***(5 marks)*** Adding data augmentations when training the UNet in step (a). Compare the segmentation performance (Dice coefficient) of the UNet trained with and without data augmentations. You should be careful when augmenting the segmentation labels.

(d) (**10 marks**) Change the training loss to the soft Dice loss in the previous step (a or b or c) where the network achieved the best segmentation performance. How about the segmentation accuracy compared with the network trained with the cross-entropy loss?

(e) ***(5 additional marks)*** By searching the literature, try to use more sophisticated neural networks and/or segmentation loss to improve your current segmentation performance.