



안와 구조물 세그멘테이션 연구 보고

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Outline

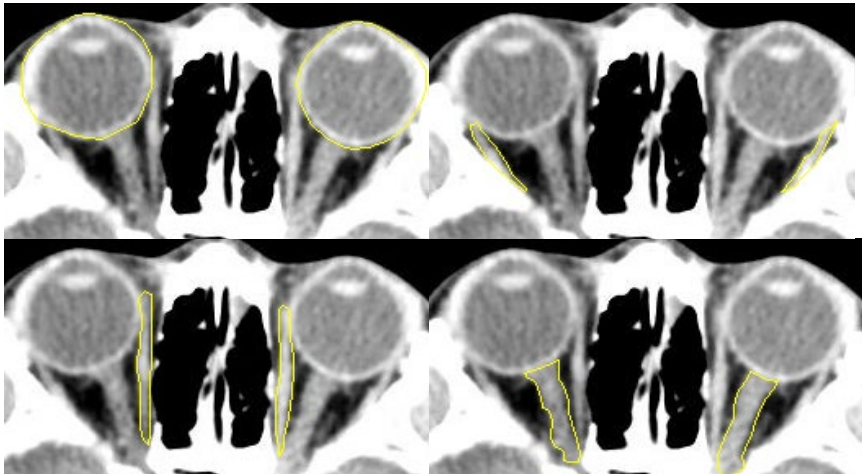
- Introduction
- Data description, Deep learning Model, Evaluation Metric
- Experiments
- Further Research

Introduction

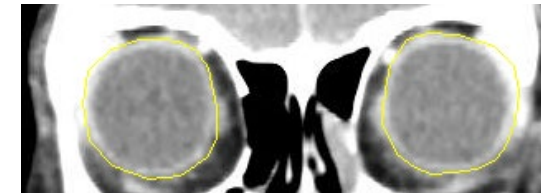
- Goal: Design Pre-trained deep learning model for segmentation of 7 structures in the orbit for use in other domains.
- Globe(눈), Superior rectus (상직근), Inferior rectus (하직근), Medial rectus (내직근), Lateral rectus (외직근), Optic nerve (시신경), Upper eyelid (상안검)
- 106 manual segmented CT scans were used, and one of axial (AX), coronal (CO), sagittal left (LT), and sagittal right (RT) was taken from each CT scan.

Dataset and Target Description

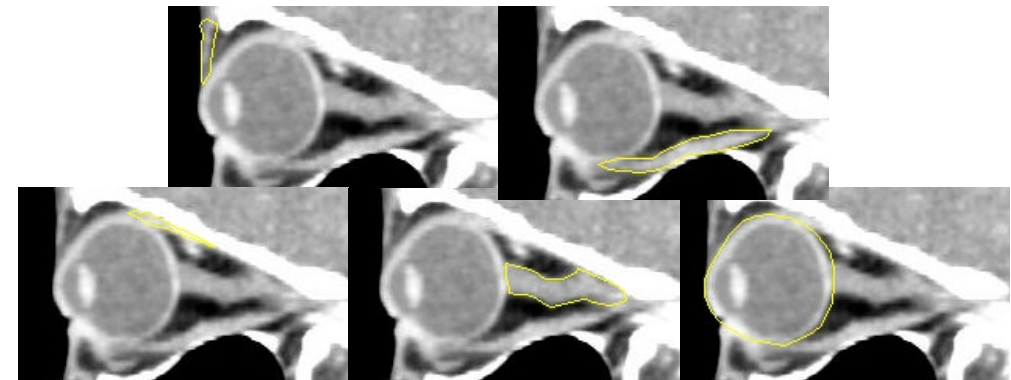
- 106 AX images, 105 CO images, 210 sagittal (SA) images
- 10 segmentation models in total



4 structures for AX



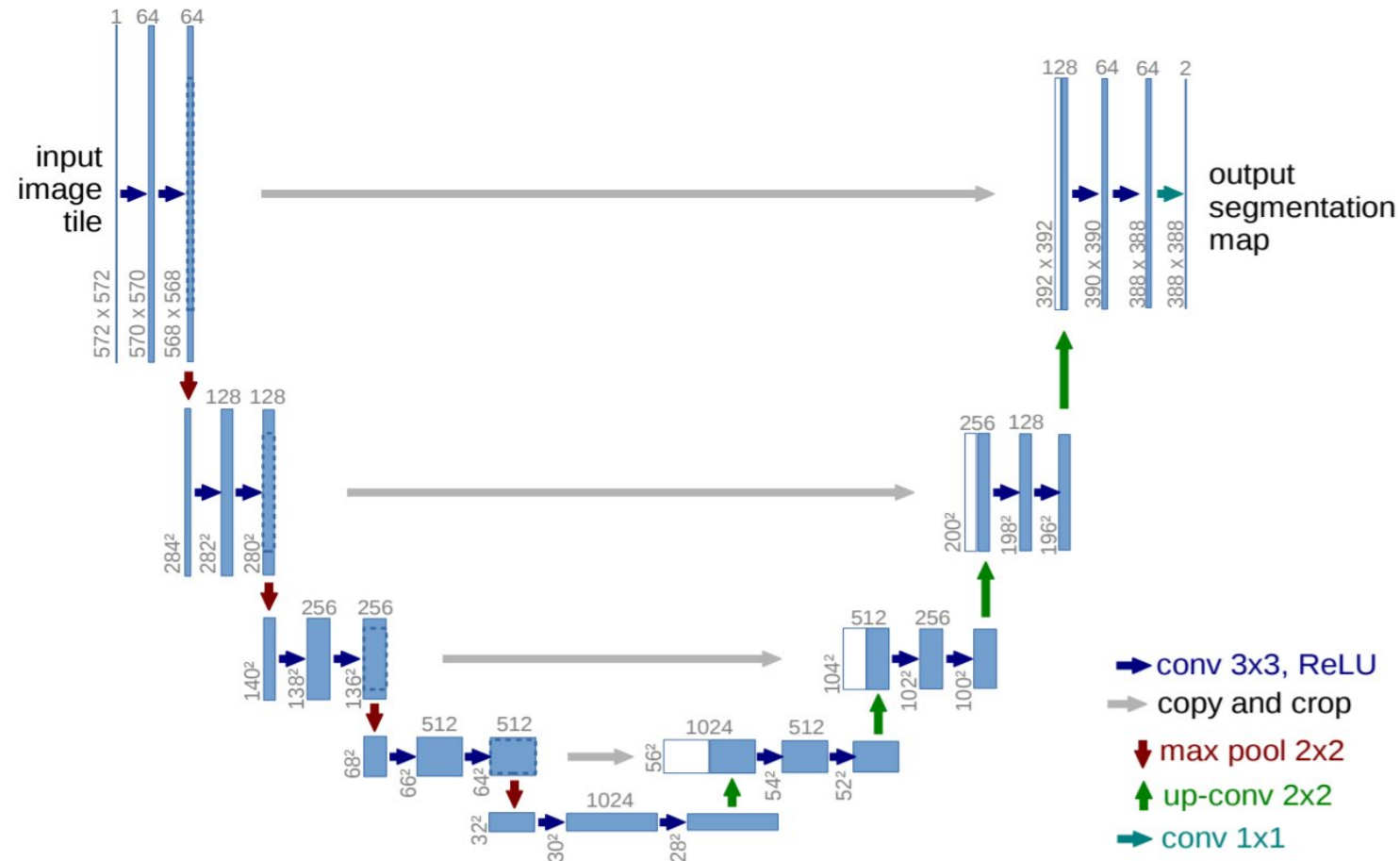
1 structure for CO



5 structures for SA

Model

- U-net (Ronneberger et al., 2015)



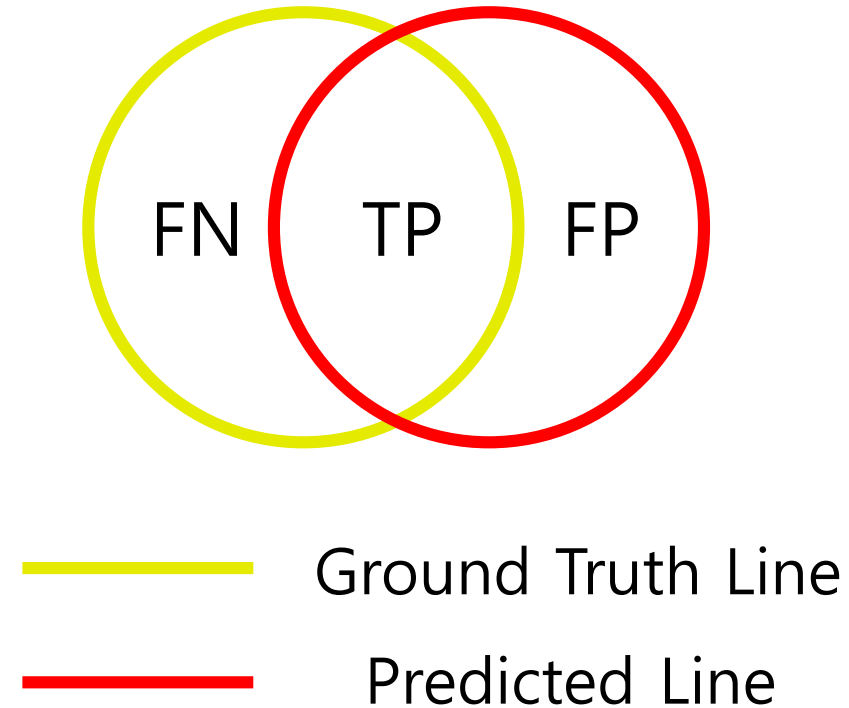
Evaluation Metric

- Dice Coefficient

$$DICE = \frac{2TP}{2TP+FP+FN}$$

- Intersection over Union

$$IoU = \frac{TP}{TP+FP+FN}$$

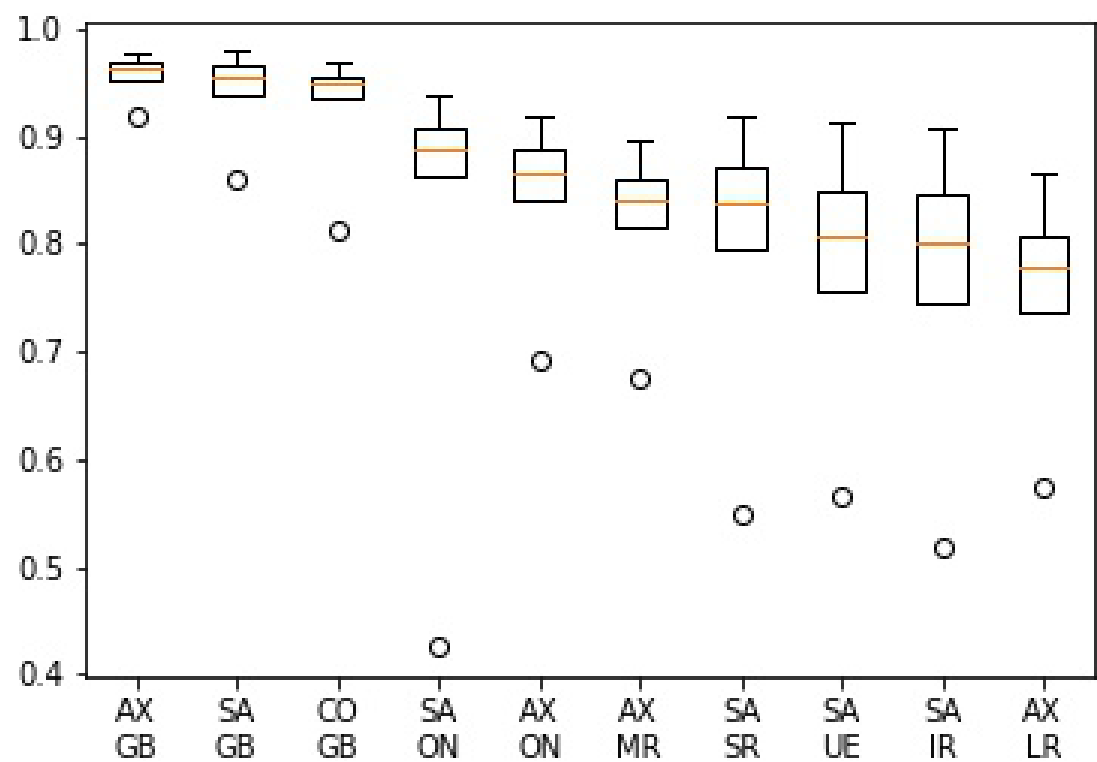


Experiments

- Split train and test set into 8:2 by random sampling
- Average of 30 experiments
- Hounsfield Unit of CT image:
 - Window Level: 0
 - Window Width: 200
- Brightness Augmentation:
AX 눈, SA 눈, CO 눈,
SA 시신경, SA 상안검, SA 하직근

Target Type	Dice Mean	IoU Mean
AX 눈	95.77%	91.92%
SA 눈	94.81%	90.24%
CO 눈	94.09%	89.05%
SA 시신경	87.20%	78.10%
AX 시신경	85.64%	75.30%
AX 내직근	82.97%	71.28%
SA 상직근	82.23%	70.43%
SA 상안검	79.82%	67.14%
SA 하직근	78.99%	65.89%
AX 외직근	76.56%	62.54%

Experiments

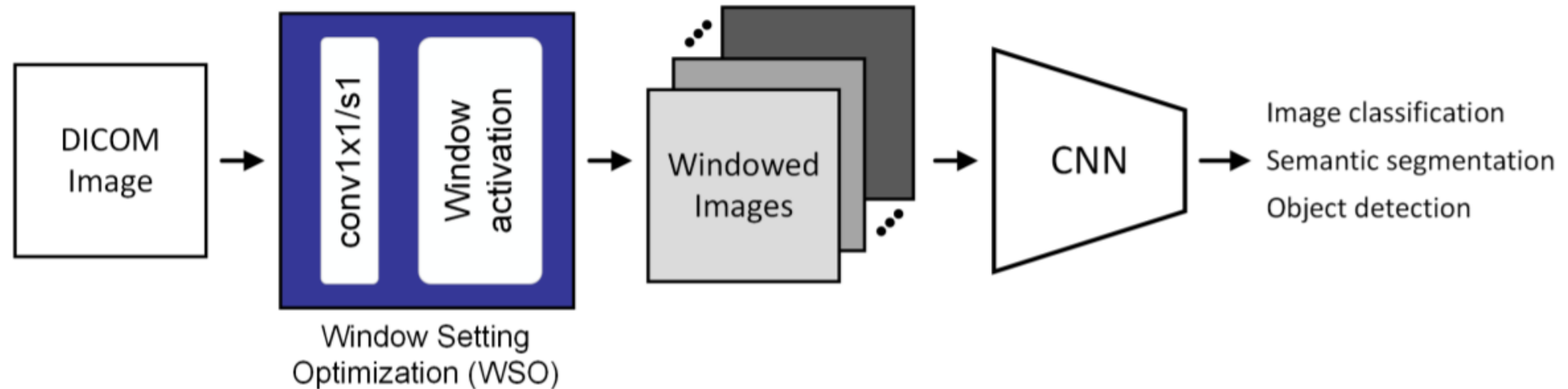


Target Type	Dice Mean	IOU Mean
AX 눈 (AX-GB)	95.77%	91.92%
SA 눈 (SA-GB)	94.81%	90.24%
CO 눈 (CO-GB)	94.09%	89.05%
SA 시신경 (SA-ON)	87.20%	78.10%
AX 시신경 (AX-ON)	85.64%	75.30%
AX 내직근 (AX-MR)	82.97%	71.28%
SA 상직근 (SA-SR)	82.23%	70.43%
SA 상안검 (SA-UE)	79.82%	67.14%
SA 하직근 (SA-IR)	78.99%	65.89%
AX 외직근 (AX-LR)	76.56%	62.54%

Further Research

- Window setting issues:

Window Setting Optimization (WSO, Lee et al., 2018)



Further Research

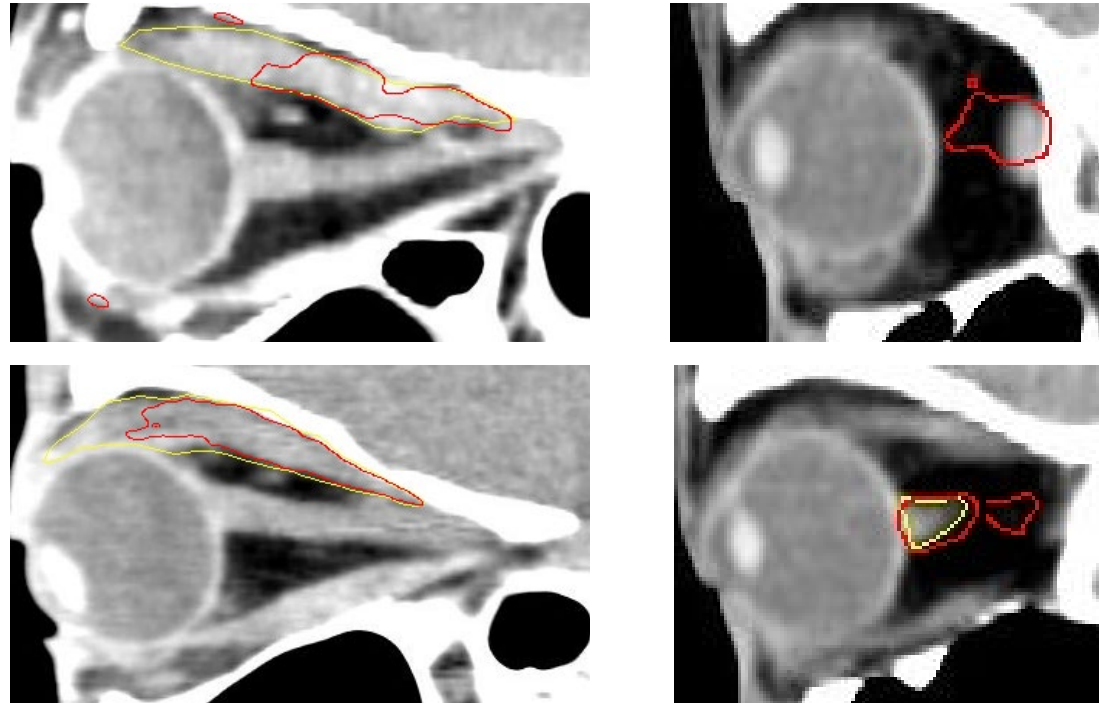
- Similar level of performance -> Can be improved
=> Adjust learning rate of WSO layer

Target Type	Dice Mean	Difference
AX 눈	94.18%	-1.59%
SA 눈	92.75%	-2.06%
CO 눈	92.06%	-2.03%
SA 시신경	85.05%	-2.15%
AX 시신경	84.01%	-1.63%
AX 내직근	81.59%	-1.38%
SA 상직근	79.43%	-2.80%
SA 상안검	77.53%	-2.29%
SA 하직근	77.62%	-1.37%
AX 외직근	73.05%	-3.51%

Further Research

- Examine Worst Case

Understanding the cause based on visual results



References

Ronneberger, Olaf, Philipp Fischer, and Thomas Brox. "U-net: Convolutional networks for biomedical image segmentation." International Conference on Medical image computing and computer-assisted intervention. Springer, Cham, 2015.

Lee, Hyunkwang, Myeongchan Kim, and Synho Do. "Practical window setting optimization for medical image deep learning." *arXiv preprint arXiv:1812.00572* (2018).