Fully Automatic Segmentation of Gross Target Volume and Organs-at-Risk for Radiotherapy Planning of Nasopharyngeal Carcinoma

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Problem Definition

- ✓ Nasopharyngeal Carcinoma (NPC) is a type of head&neck cancer.
- ✓ Statistics in 2018: 120079 newly diagnosed case & 72000 associate deaths.
- ✓ Intensity-Modulated Radiotherapy (IMRT) is the most common technique for NPC treatment.
- ✓ Manual delineation of Gross Tumor Volumes (GTVs) and Organs at Risk (OARs) is demanding.

Objective and Dataset

- ✓ Automatically segment 45 OARs (Task1)
- ✓ Automatically segment 2 GTVs; Primary Tumors, and Lymph Nodes (Task2)
- ✓ Bi-modal CT volumes: normal CTs, contract-enhanced CTs (ceCTs)
- ✓ Co-registered images: 120 subjects (training), 20 subjects (validation), 60 subjects (test)

Image Preprocessing

I. Intensity Enhancement:

Windowing Hounsfield range: enhancing the contrast

Task	Clipping Range	
	CT	ceCT
Task 1 (OARs)	-300 : 800	-400 : 2000
Task 2 (GTV)	-600 : 600	-1000 : 1000

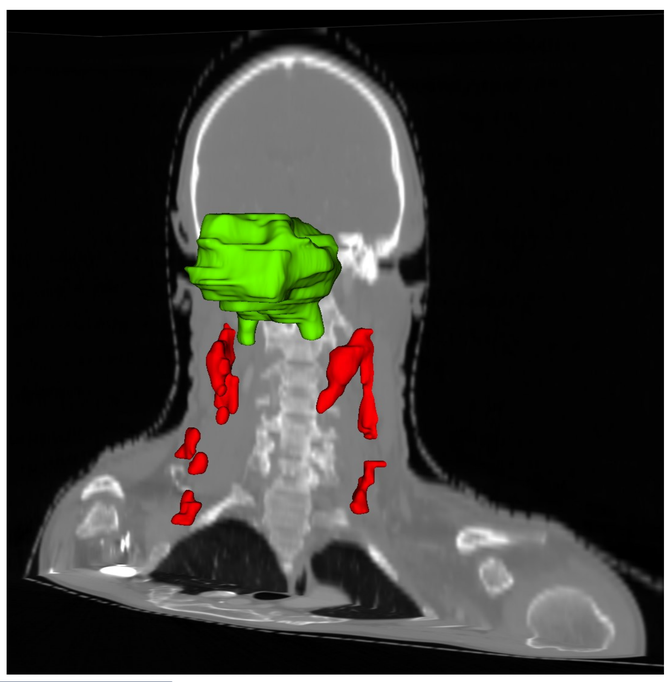
II. Volume Cropping:

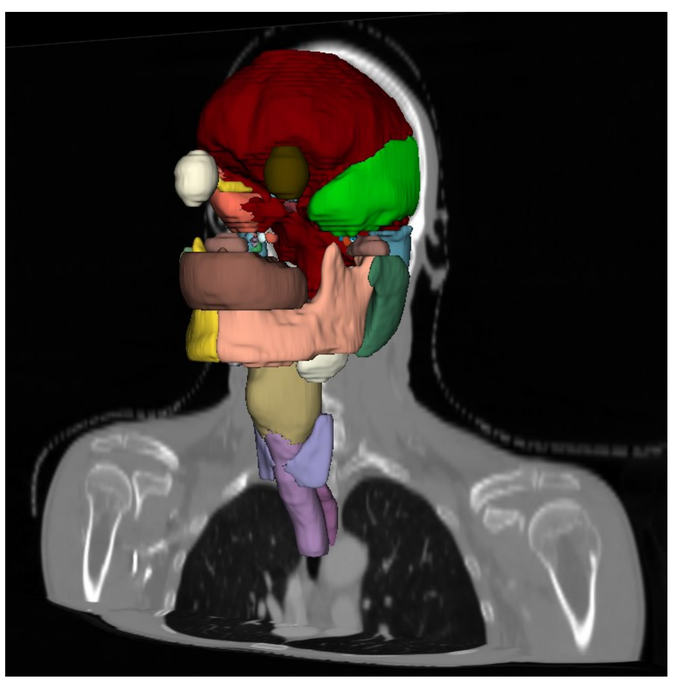
Avoiding the computational complexity

Segmentation Model

✓ nnUnet-V1

Parameters	OARs model	GTVs model
Trainer class	nnUnetTrainerV2	nnUnetTrainerV2
Objective function	Dice + BCE	Dice + BCE
Optimizer	SGD	SGD
Augmentation	True except for the flipping	True
Patch size	64×192×160	80×192×128
# of feature maps in the base layer	32	32
# of pooling per axis	[4,5,5]	[4,5,5]
# of epochs	2500	700
# of training batches per epoch	250	250
# of validation batches per epoch	50	50
Initial learning rate	0.01	0.01
Batch size	2	2
# of folds	5	5





Results

Model	Training Set (Dice Metric)	
	Mean±std	**Median**
GTVs	0.758±0.080	0.776
OARs	0.851±0.061	0.845

Model	**Phase**	**Mean±std**		
		Dice	**Normalized Surface Dice**	**Ranking**
GTVs	Validation	0.790±0.089	0.739±0.119	#2
OARs		0.887±0.076	0.905±0.087	#2
GTVs	Test	0.731±0.128	0.498±0.128	??
OARs		0.854±0.101	0.849±0.132	??

References

1 - nnU-Net: a self-configuring method for deep learning-based biomedical image segmentation; https://doi.org/10.1038/s41592-020-01008-z
2 - TotalSegmentator: Robust Segmentation of 104 Anatomic Structures in CT Images; https://doi.org/10.1148/ryai.230024