BG-Net: Boundary-Guided Network for Lung Segmentation on Clinical CT Images

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1. Motivation

- Quick or early diagnosis of lung diseases is crucial in clinics, especially for the global pandemic of the novel coronavirus 2019 (COVID-19) at present.
- Computed tomography (CT) has been widely used for the diagnosis of lung diseases in daily clinics. Lung segmentation on CT images is a crucial step for a computer-aided diagnosis system of lung diseases.
- Existing works design their deep networks for lung segmentation by only using the information from inside lungs, but ignoring the valuable cues provided by lung boundaries which can provide visual cues that can help radiologist to identify the lung regions .
- This work proposes a boundary-guided network (BG-Net) to segment lung regions on clinical CT images. It contains two auxiliary branches that can separately extract lung regions and the corresponding lung boundaries, and an aggregation branch that unifies the information from both tasks for more accurate lung segmentation.
- Specifically, a boundary attention guidance module (BAGM) is designed in the aggregation branch, which exploits lung boundary cues for guiding the network to learn more powerful lung segmentation features.

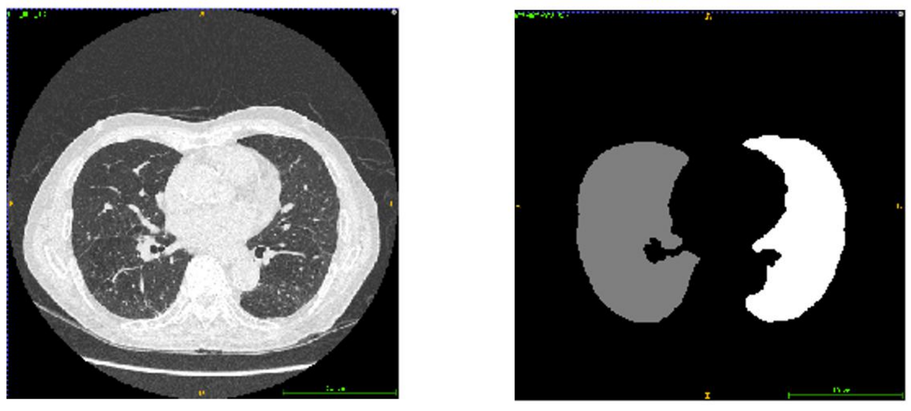

Figure 1: An example of lung segmentation on clinical CT image

2. Method

Network Structure

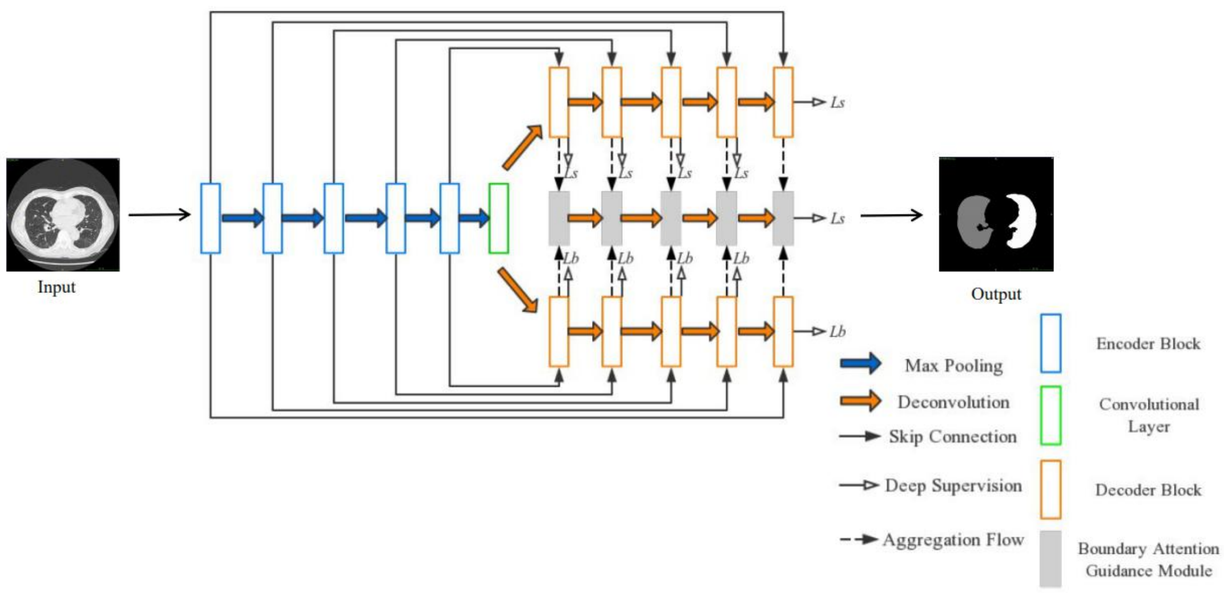

Figure 2: Illustration of Boundary-Guided Network architecture

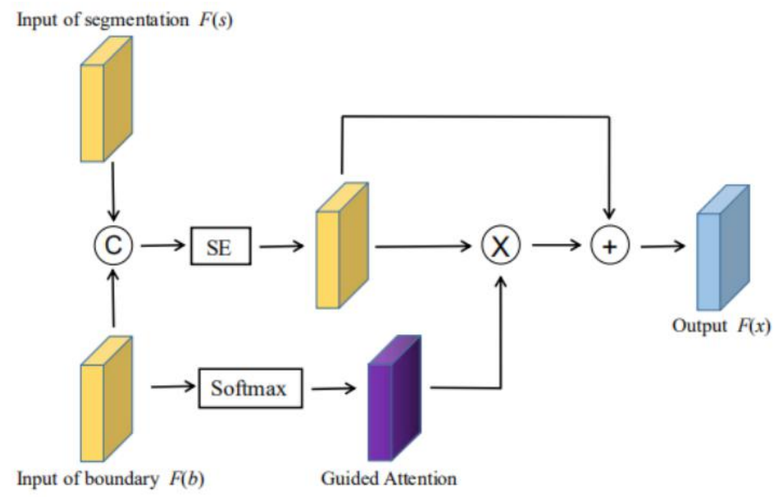

Figure 3: Illustration of Boundary Attention Guidance Module

3. Results

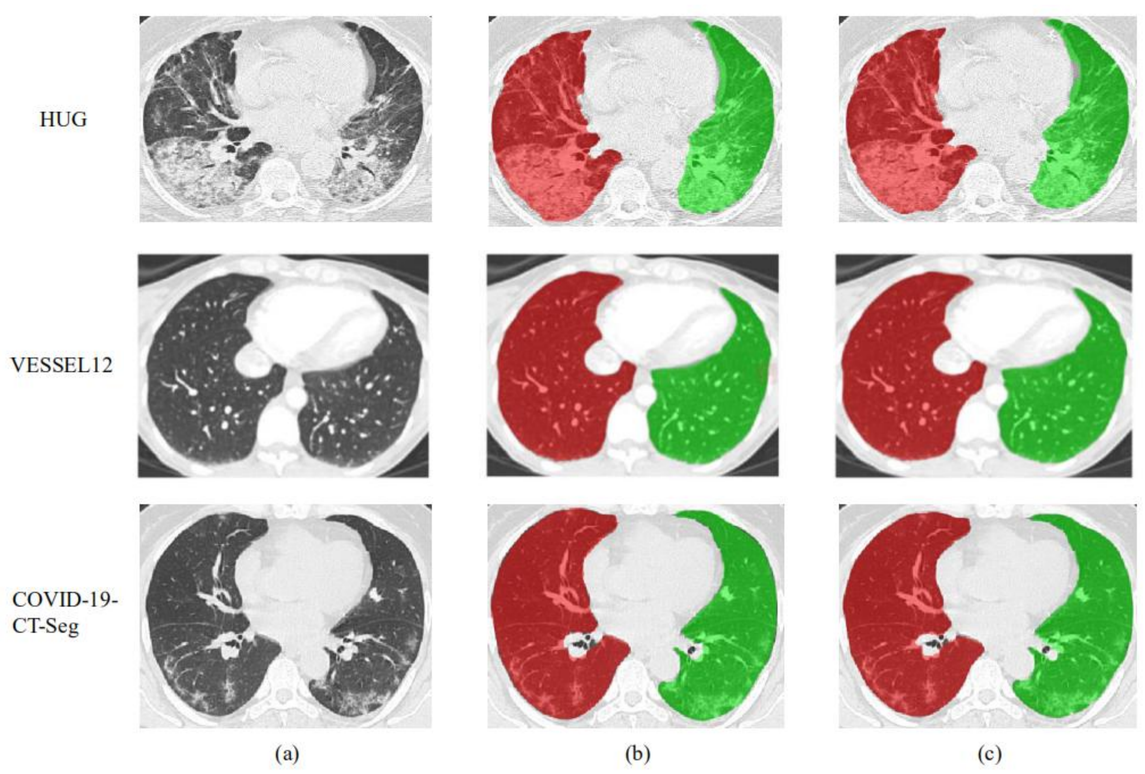

Figure 4: Examples of visualization results by the proposed method. (a) lung CT image, (b) ground truth, (c) prediction result.

Table 1: Comparison of the proposed method with methods on the HUG and VESSEL12 datasets

Dataset	Method	DSC	ASD	HD
HUG	Harrison et al.	0.9790	0.3610	-
	Jeovane et al.	0.9867	-	-
	LaLonde et al.	0.8892	-	37.1710
	Ours	**0.9889**	**0.1304**	**0.6655**
VESSEL12	Jeovane et al.	0.9919	-	-
	Soliman et al.	0.9900	-	-
	Ours	**0.9945**	**0.4981**	**1.4041**

Table 2: Comparison of the proposed method with methods on the COVID-19 dataset

Dataset	Method	DSC		ASD		HD	
		Left	*Right*	*Left*	*Right*	*Left*	*Right*
COVID-19-CT-Seg	HED	0.8064	0.8207	11.2448	9.9281	64.1505	60.8332
	FCN	0.9233	0.9298	10.1031	9.7388	54.8521	53.5381
	U-Net	0.9481	0.9501	4.7416	4.5995	46.7094	43.7777
	Ma et al.	0.9220	0.9550	-	-	-	-
	Ours	**0.9624**	**0.9671**	**2.8405**	**1.4677**	**15.8190**	**12.5875**

4. Conclusion

- The boundary-guided network combines two auxiliary branches of lung segmentation and the corresponding boundary extraction.
- A boundary attention guidance module is proposed in the aggregation branch, which fully utilize boundary information to provide a boundary guidance for segmentation information.