Unsupervised Detection of Pulmonary Opacities for Computer-Aided Diagnosis of COVID-19 on CT Images

Rui Xu¹, Xiao Cao¹, Yufeng Wang¹, Yen-Wei Chen², Xinchen Ye¹, Lin Lin¹, Wenchao Zhu¹, Chao Chen¹, Fangyi Xu¹, Yong Zhou³, Hongjie Hu³, Shoji Kido⁴ and Noriyuki Tomiyama⁴
¹Dalian University of Technology  ²Ritsumeikan University  ³Zhejiang University School of Medicine  ⁴Osaka University

Background

Diagnosis of COVID-19 on CT Images

Figure 1: Existing deep learning based methods for COVID-19 diagnosis
- Existing methods tend to extract features from the entire CT images which limits their performances.
- Opacity-aware methods improve the capacity of COVID-19 diagnosis but require human annotation of pulmonary regions on CT images which costs too much time and human labors.

Method

Opacity Detector

Figure 4: The architecture of the proposed opacity detection model.
- Inference.
  1. Get the difference map by computing reconstruction error.
  2. After normalization, thresholding and multiplied by segmentation map, a binary mask of opacity in lung region can be obtained.

Experimental

Figure 5: Visualization of segmentation and opacity detection results on COVID-19 and CAP cases.
- Anomaly detection aims at identifying abnormal cases by training only on normal data which is suitable for locating regions of pulmonary opacities on CT images.

Proposed Method

Figure 3: An overview of the proposed method.
1. The input CT slices are fed into lung segmentation model and opacity detector respectively.
2. The differences between the reconstructed images and original images are computed and multiplied by segmentation results.
3. After thresholding, binary masks generated from difference maps incorporate with original images are utilized for feature extraction and classification to get the final results.

Conclusion

We propose an opacity detection model for diagnosis of COVID-19. By applying opacity detection, the opacity regions can be segmented in an unsupervised manner which is a key to overcome the bottleneck of insufficient labeled data.