Abstract

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A Two-Stage Framework for Automated Malignant Pulmonary Nodule Detection in CT Scans

This research is concerned with malignant pulmonary nodule detection (PND) in low-dose CT scans. Due to its crucial role in the early diagnosis of lung cancer, PND has considerable potential in improving the survival rate of patients. We propose a two-stage framework that exploits the ever-growing advances in deep neural network models, and that is comprised of a semantic segmentation stage followed by localization and classification. We employ the recently published DeepLab model for semantic segmentation, and we show that it significantly improves the accuracy of nodule detection compared to the classical U-Net model and its most recent variants. Using the widely adopted Lung Nodule Analysis dataset (LUNA16), we evaluate the performance of the semantic segmentation stage by adopting two network backbones, namely, MobileNet-V2 and Xception. We present the impact of various model training parameters and the computational time on the detection accuracy, featuring a 79.1% mean intersection-over-union (mIoU) and an 88.34% dice coefficient. This represents a mIoU increase of 60% and a dice coefficient increase of 30% compared to U-Net. The second stage involves feeding the output of the DeepLab-based semantic segmentation to a localization-then-classification stage. The second stage is realized using Faster RCNN and SSD, with an Inception-V2 as a backbone. On LUNA16, the two-stage framework attained a sensitivity of 96.4%, outperforming other recent models in the literature, including deep models. Finally, we show that adopting a transfer learning approach, particularly, the DeepLab model weights of the first stage of the framework, to infer binary (malignant-benign) labels on the Kaggle dataset for pulmonary nodules achieves a classification accuracy of 95.66%, which represents approximately 4% improvement over the recent literature.