3D U-Net Based Automatic Segmentation of Organs at Risk From CT

Ting Liu, Xiaodong He, Ruifeng Zhao, Alvin Wang, Xiaoliang Li, Feng Shi, Lihua Tian.

Purpose: Contouring the organs at risk (OAR) for radiotherapy planning is time consuming and prone to inter- and intra- observer variations. In this study we developed a system for automatic segmentation of OARs from CT volume based on 3D U-Net framework.

Methods: 3D U-Net neural network is implemented on TensorFlow framework. A data set consisting of 35 CT scans with OARs delineated by physicians are used for training the neural network. The training set is first expanded by rotation and scaling operations to improve the robustness of the training results. Neural network training is divided into two phases: in the first stage, the down-sampled images are taken as the input, and the cross entropy is used as the optimization target, then the rough bounding boxes of different OARS are obtained. In the second stage, the rough bounding boxes from the last phrase are up-sampled to a specified size, the network is optimized with respect to the cross entropy and dice coefficient in an iterative way. Finally, patient CT volume is feed into the optimized neural network, and contours of each OAR are obtained.

Results: We test the system on different body parts and calculated the dice coefficients. The dice coefficient of organs which have obvious boundary with the surrounding tissues such as brain, mandible, lung and kidney, is above 90%, while the dice coefficient of organs which have no obvious boundary with surrounding tissues or large self-variability such as small intestine, esophagus and rectum, is around 60%.

Conclusion: With our in-house developed system for contouring work, physicians just need to fine-tune the results of automatic segmentation, which saves about 80% of the contouring time.