RRc-UNet 3D for lung tumor segmentation from CT scans of Non-Small Cell Lung Cancer patients

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Context
- Lung cancer is the second most common cancer worldwide, and Non-Small Cell Lung Cancer (NSCLC) accounts for 85% of all lung cancers.
- Computed Tomography (CT) is an effective medical screening for the diagnosis and detection of lung cancer.
- Automatic segmentation of tumors in lung CT scans is highly desirable because manual segmentation is time-consuming and labor-intensive.
- Deep learning models provide the segmentation of medical images with a high accuracy.

Dataset and data augmentation
- The experimental CT scans come from 2 sources (public and local datasets):
  1. Train/validate the model on 3 public datasets (494 images).
  2. External validation (testing) on local dataset (41 images).
- Data pre-processing: truncate intensity, z-normalization, crop and convert the CT to the new size.
- Data augmentation: randomly apply during training process (flip, deformation, and affine transformation).

Residual Recurrent (RRc) block and RRc-UNet 3D model
- Input: two-channel input (CT scan and segmentation of lung parenchyma).
- Output: segmentation of 3 categories.
- RRc-Unet 3D architecture was validated by an ablation study.

Evaluation metrics
- Dice score coefficient (DSC)
- Jaccard similarity (IOU)
- F1 score

NSCLC tumor segmentation
- Top = prediction. Bottom = ground truth.
- From left to right: X-axis, Z-axis, and 3D view (DSC > 0.95).

Evaluation
The performance metrics for segmentation on validation set.

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<th>DSC</th>
<th>IOU</th>
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<tr>
<td>On 3 categories</td>
<td>0.863</td>
<td>0.997</td>
<td>0.9982</td>
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<td>On tumor seg.</td>
<td>0.8777</td>
<td>0.7274</td>
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The Dice coefficient on testing images: 0.7682
The Dice coefficient histogram of the patients in the testing set: 30 out of 41 cases obtained good predictions on tumor region.

Conclusion
1. A RRc-UNet 3D model to provide tumor segmentation from CT scans of NSCLC patients.
2. The proposed model provided an accurate segmentation with a Dice coeff. of 0.8777 for the validation set.
3. The model can work with a whole 3D volume of the CT scan. The model can be applied to different medical image segmentation tasks.

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