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

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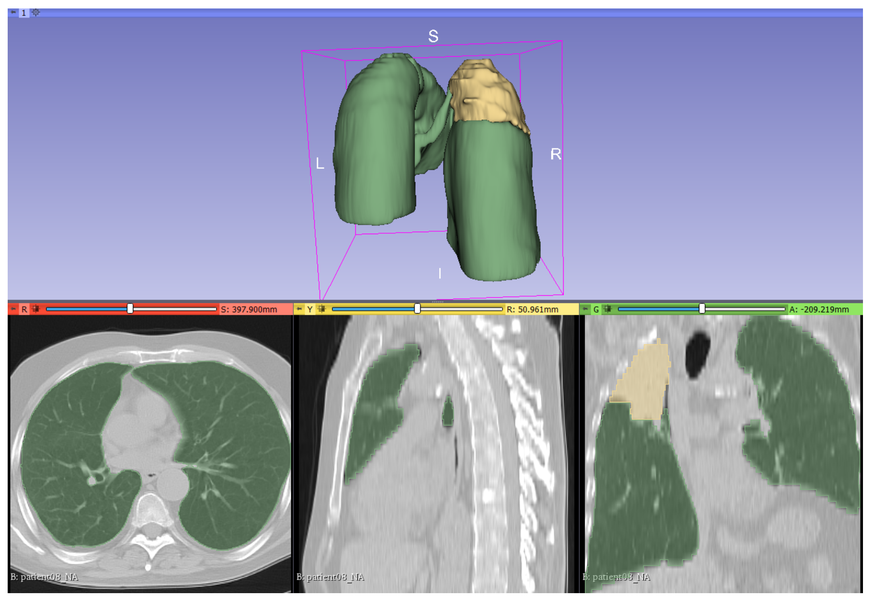
Context

- 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.

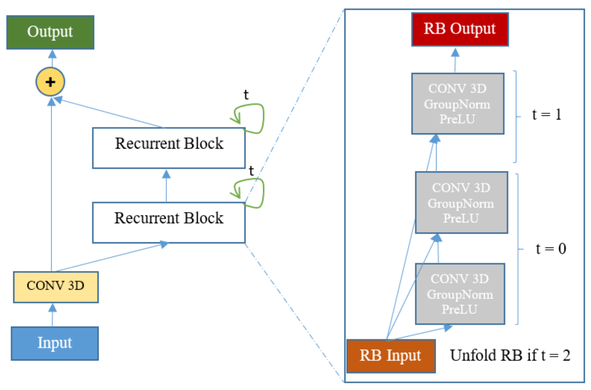
CT scan (3D volume) of a NSCLC patient and segmentation



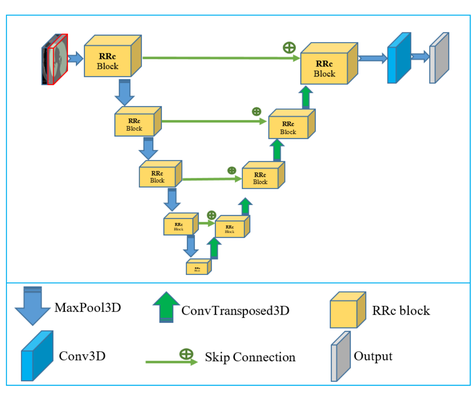
Dataset and data augmentation

- 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



Residual Recurrent block (t=2)



RRc-UNet 3D model with 5 levels

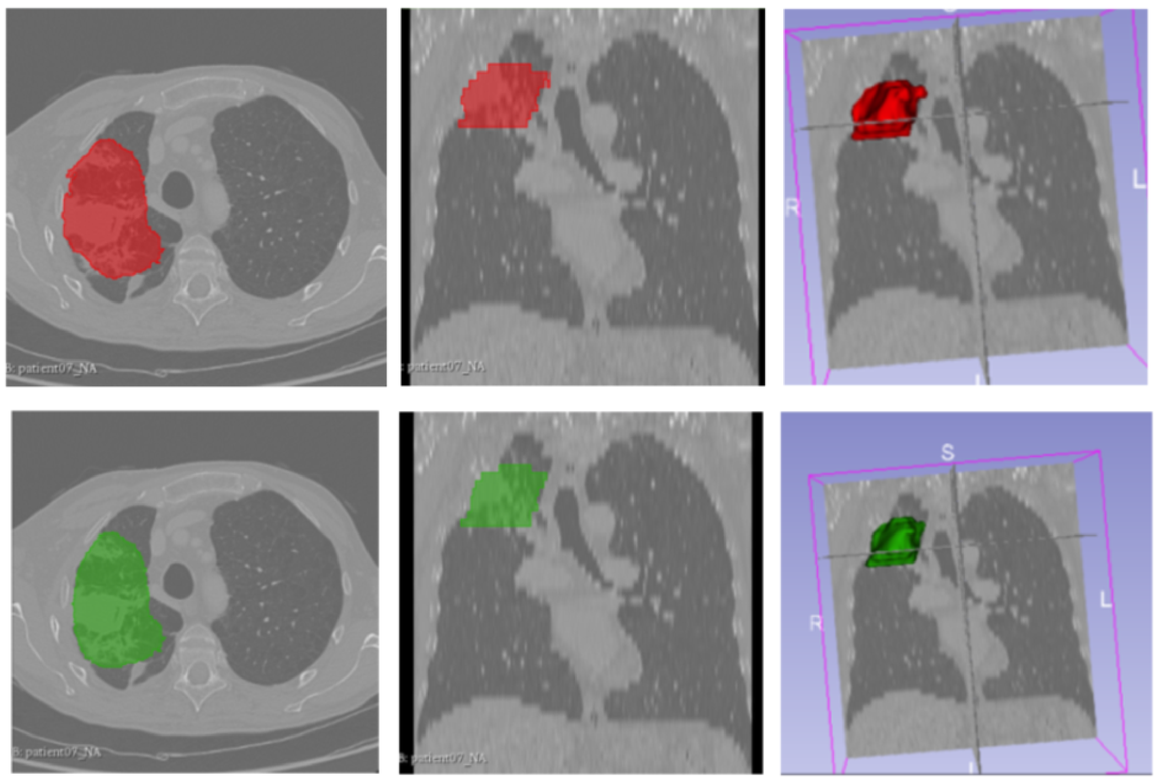
- Input: two-channel input (CT scan and segmentation of lung parenchyma).
- Output: segmentation of 3 categories.
- RRc-Unet 3D architecture was validated by an ablation study.

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 ($DSC > 0.95$).



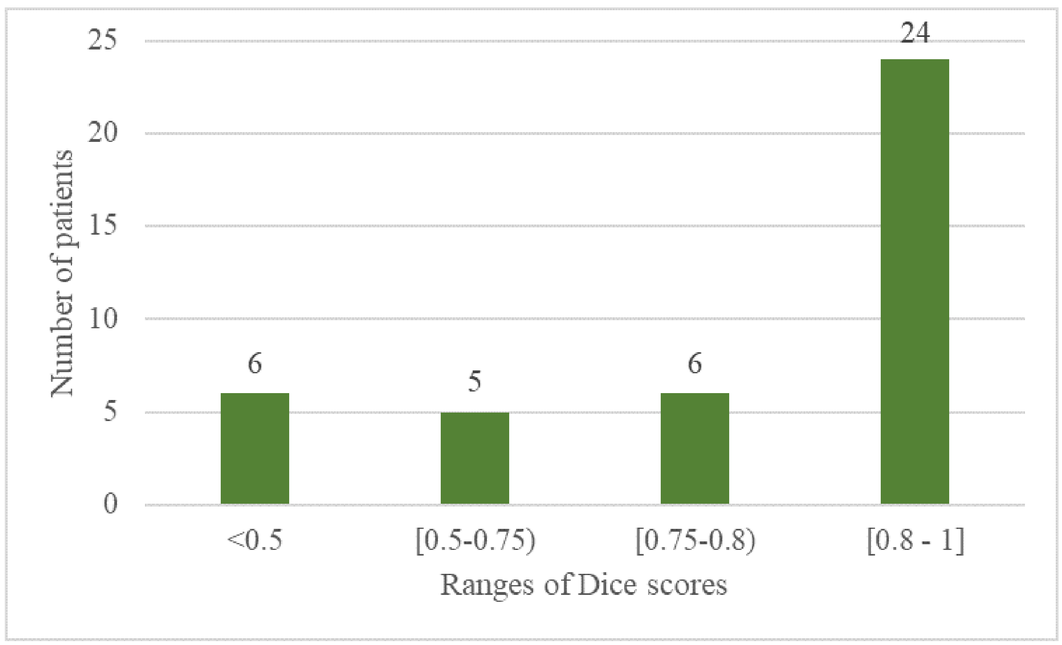
Evaluation

The **performance metrics** for segmentation on validation set.

	DSC	IOU	F1
On 3 categories	0.863	0.9971	0.9982
On tumor seg.	**0.8777**	0.7274	-

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.

Acknowledgments

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