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INSIGHT-BASED DECISION MAKING

Generalizability study of a deep learning model for automated lung segmentation on pediatric CT scans

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Disclosures

- Flore Belmans, Francois Blistein, Ingrid van Peufflik and Akshayaa Vaidyanathan are salaried employees of Radiomics.
- Wim Vos, Sean Walsh and Mariaelena Occhipinti have shares in the company Radiomics.
- Wim Vos, Sean Walsh and Mariaelena Occhipinti receive a fee from Radiomics, outside the submitted work.

Deep learning for medical image segmentation

The extraction of quantitative information from medical images requires the segmentation of the organ or condition of interest

Manual Segmentation

Time consuming

Intra and inter reader variability

Automatic Segmentation

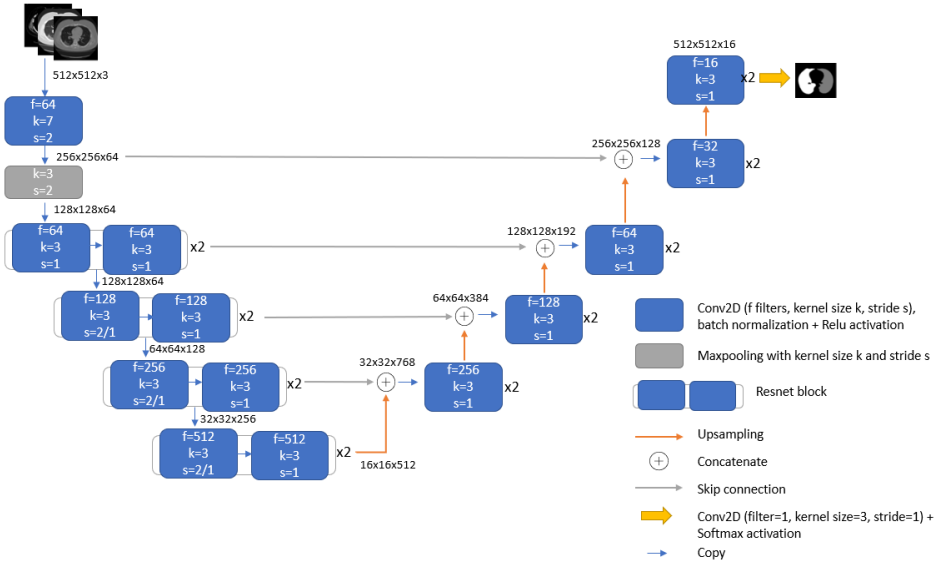
Deep learning (DL) for automated segmentation

Importance of generalizability studies

The validation of a DL model for lung segmentation on a pediatric patient cohort

Methods: Model

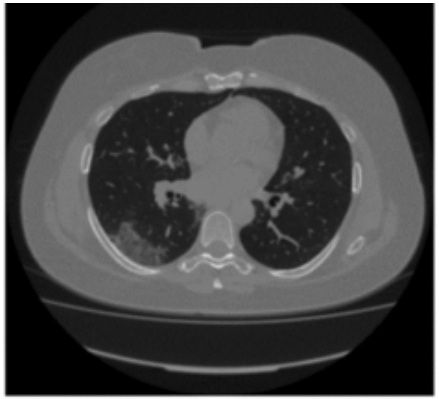
- Automatic in-house lung segmentation model[1]
- Convolutional neural network (CNN)
- U-net with resnet-18 encoder + soft-max activation



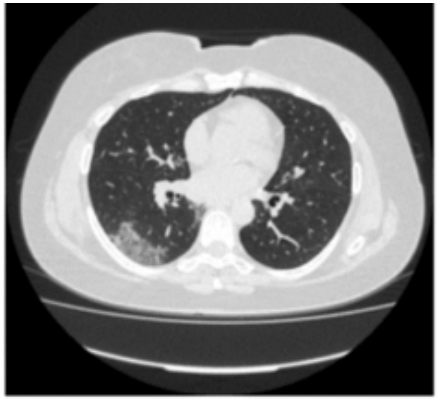
Methods: Model input

- Trained on axial slices (512x512 images)
- Channel 1 – original intensities
- Channel 2 – lung window (W=1500HU, L=-600HU)
- Channel 3 – mediastinal window (W=350HU, L=50HU)

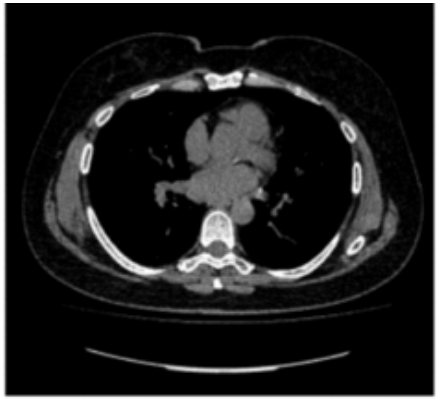
Channel 1



Channel 2

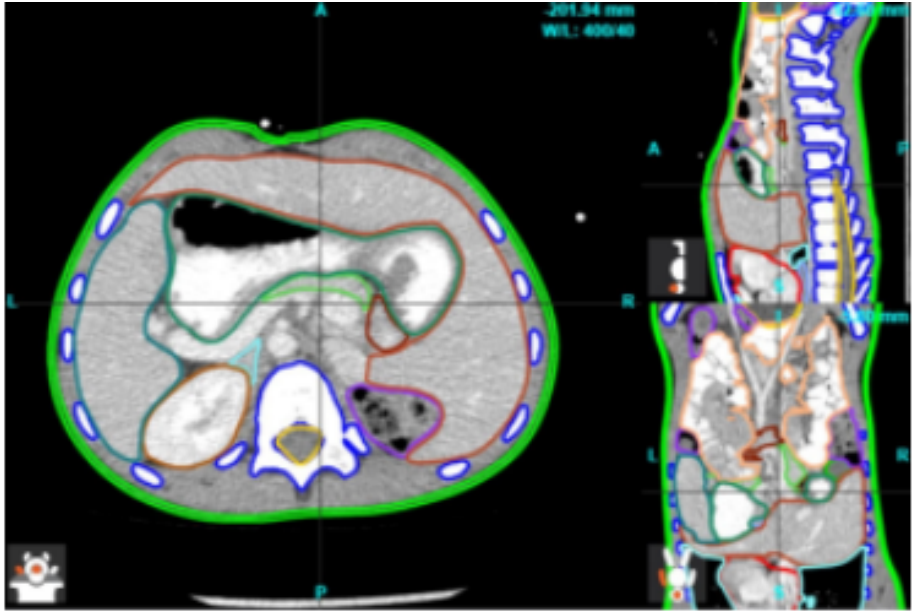


Channel 3



Methods: Test dataset

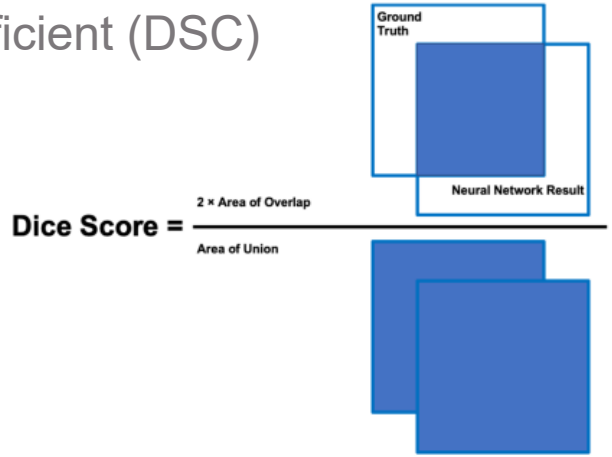
- Pediatric Chest/Abdomen/Pelvic CT Exams with Expert Organ Contours (Pediatric-CT-SEG) – The Cancer Imaging Archive [1]
- 359 CT exams based on routine clinical indications
- Age distribution
  - 5 days to 16 years
  - Mean age 7
- 180 Male, 179 Female



1. K. Clark et al., J. Digit. Imaging, 26, 6, 1045–1057, 2013

Methods: metrics

- Dice Similarity Coefficient (DSC)



- Relative absolute volume difference (ravd)

$$ravd = \frac{vol_{CNN} - vol_{GT}}{vol_{GT}} * 100\%$$

Results

359 scans

QC

- *Missing slices (n=6)*
- *Absence of lungs (n=6)*

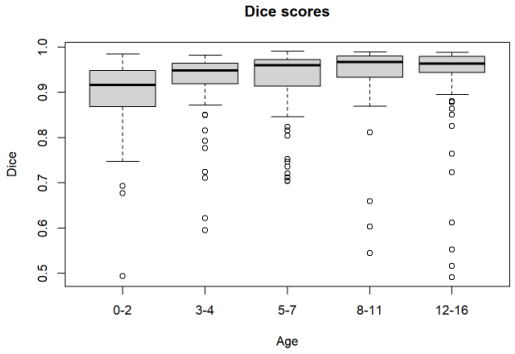
347 scans

Subset analysis

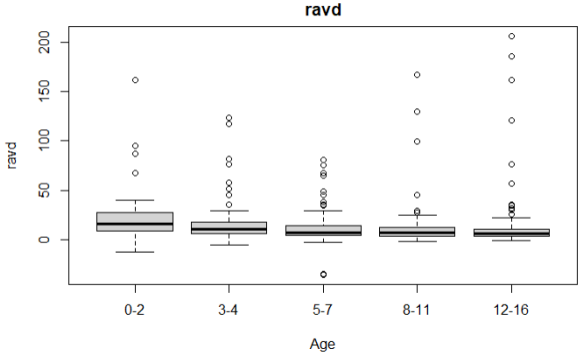
Age categories

- 0-2 (n=60)
- 3-4 (n=70)
- 5-7 (n=77)
- 8-11 (n=61)
- 12-16 (n=78)

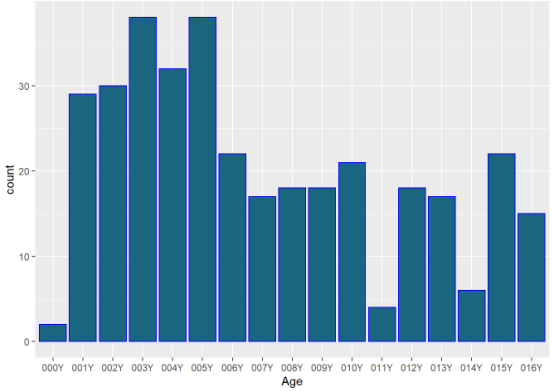
DL model predictions



Median DSC 0.95 (IQR 0.06)

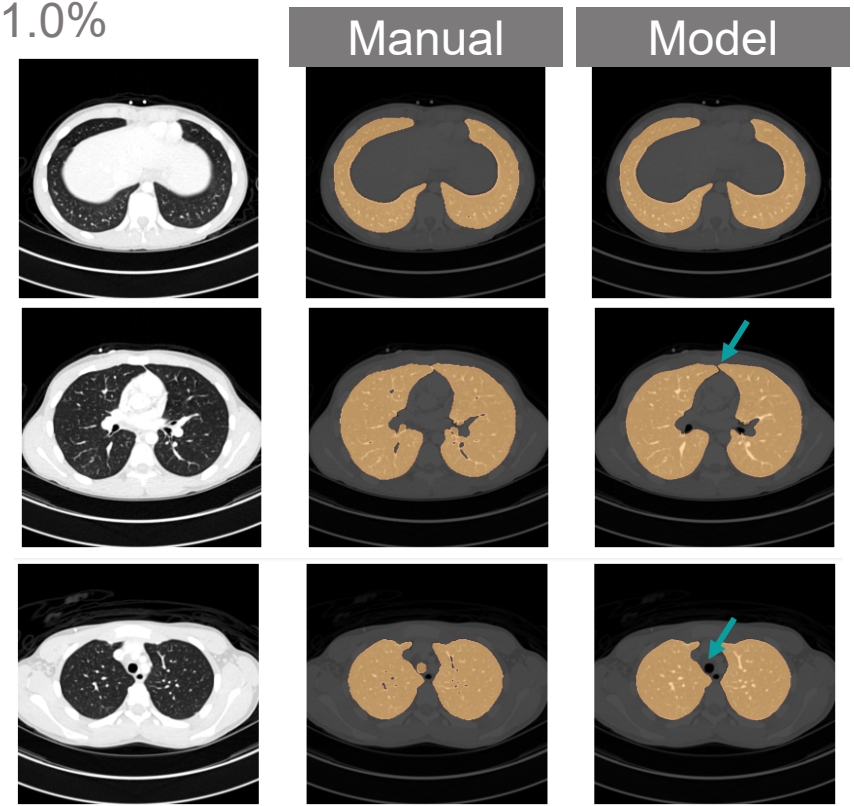


Median ravd 8.11 % (IQR 14.10 %)



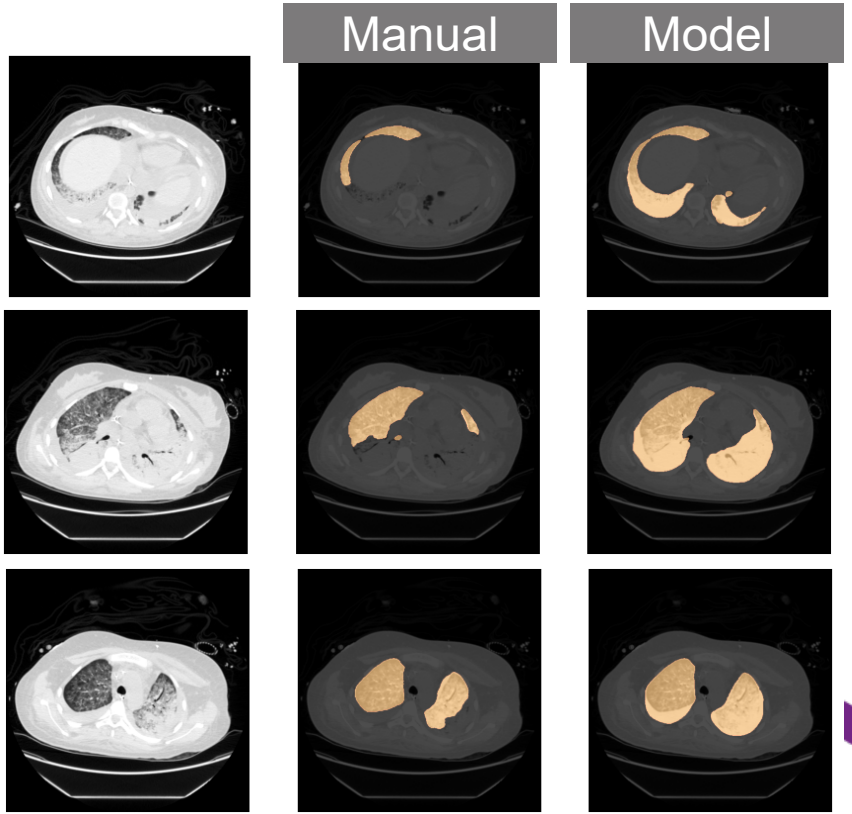
Results: example 1

- DICE = 0.98, ravd = 1.0%



Results: example 2

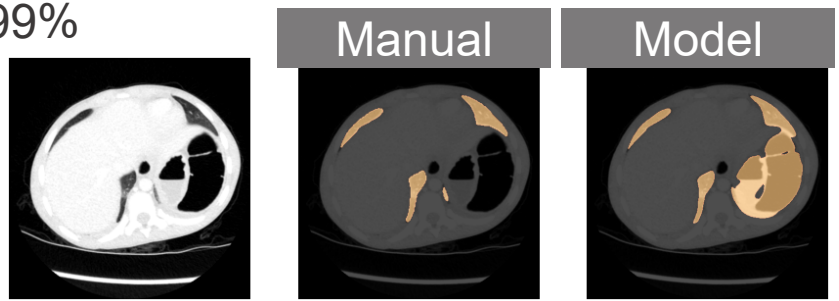
- DICE = 0.61, ravd = 121%
  - Questionable quality of the manual segmentations in the presence of abnormalities
  - In this case, <u>model performs better</u>



Results: example 3 & 4

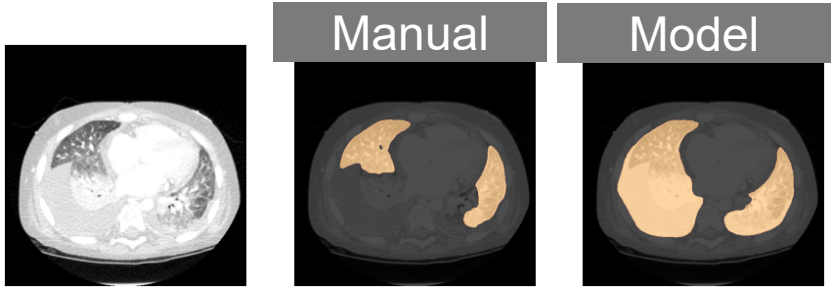
- DICE = 0.66, ravd = 99%

Model segmented abdominal air



- DICE = 0.60, ravd = 123%

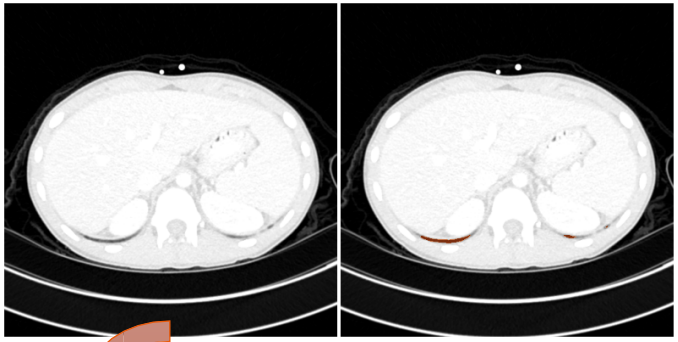
Model segmented deflated lung lobe



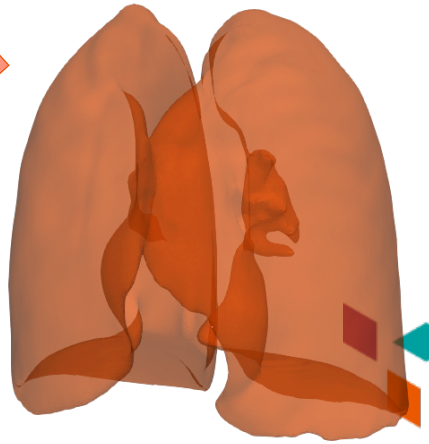
Conclusion

DL for automated lung segmentation

- ✓ Fast
- ✓ Consistent
- ✓ 100% reproducible
- ✓ Generalizable to pediatric CT scans (Median Dice=0.95)
- ✓ Robust to the presence of consolidation, GGO, tumors



3D rendering



Future improvements

- Robust to other abnormalities (deflated lung lobes, abdominal air)

Thank you

Questions?

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