Thoracic Volume and Pleural Effusion Segmentations in Diseased Lungs for Benchmarking Chest CT Processing Pipelines (PleThora)

Summary

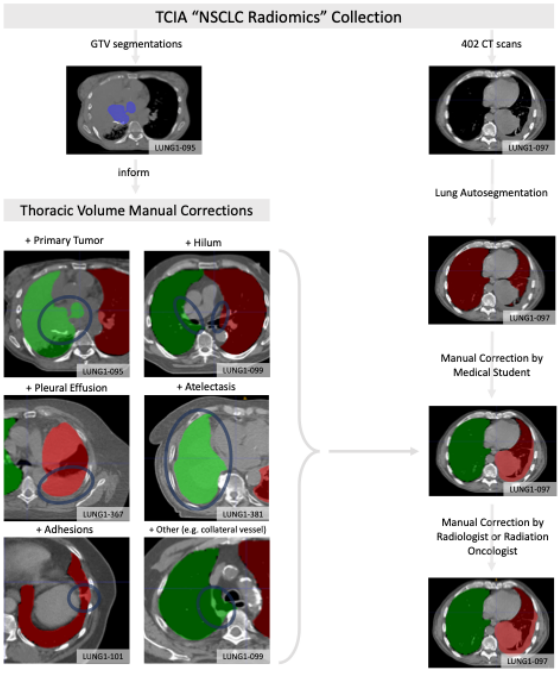
Automated or semi-automated algorithms intended for chest CT analyses typically require the creation of a 3D map of the thoracic volume as their initial step. Identifying this anatomic region precedes fundamental tasks such as lung structure segmentation, lesion detection, and radiomics feature extraction in analysis pipelines. However, automatic approaches to segment the thoracic volume maps struggle to perform consistently in subjects with diseased lungs – yet this is exactly the circumstance for which pipeline analyses would be most useful.

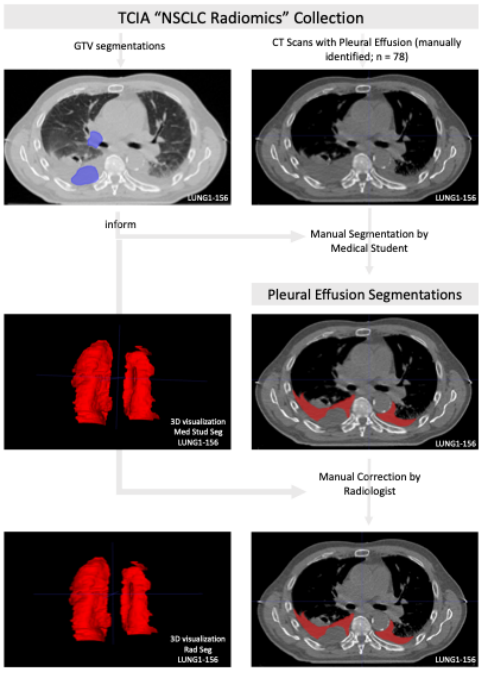
To address this need, we have created PleThora, a dataset of **ple**ural effusion and **thora**cic cavity segmentations in subjects with diseased lungs. PleThora consists of left and right thoracic cavity segmentations delineated on 402 CT scans from The Cancer Imaging Archive NSCLC-Radiomics collectio n as well as separate segmentations labeling pleural effusions alone. Thoracic cavity segmentations include lung parenchyma, tumor, atelectasis, adhesions, and effusion. PleThora is a tool for medical image preprocessing and segmentation researchers to build and compare approaches for region-of-interest identification and analysis.

The thoracic cavity segmentations were generated automatically by a U-Net based algorithm trained on chest CTs without cancer, manually corrected by a medical student, and revised by a radiation oncologist or a radiologist. Pleural effusion segmentations were manually delineated by a medical student and revised by a radiologist. Expert GTV segmentations already provided by the NSCLC-Radiomics collection helped inform our segmentations, and areas of the effusion that overlap with GTVs are not included. Researchers interested in discriminating between GTV and effusion using imaging biomarker inputs may find our pleural effusion segmentations useful, especially when paired with the GTV segmentations provided in the NSCLC-Radiomics collection.

Tabular data are also provided, including GTV, thorax, and effusion volumes (in cm3), tumor location, and image metadata. Additionally, we standardized a train/test split for training deep learning algorithms with the thoracic cavity segmentations.

Note: These segmentations use the RPI orientation, but the original DICOM files are oriented using the RAI convention. As a result, some tools such as ITK-SNAP will not render the segmentations in the correct orientation when visualized. The authors of these data suggest using software like Mango (http://ric.uthscsa.edu/mango/) or to convert to DICOM files to NIfTI with software like dcm2niix (https://github.com/rordenlab/dcm2niix) to address this issue.





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- The University of Texas Health Science Center School of Biomedical Informatics, Houston, TX, USA
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Data Access

Data Access

Data Type	Download	License
Thoracic Segmentations (ZIP of .nii, 402 subjects, 402 files, 26.9 MB)	*Download*	CC BY 3.0
Pleural Effusion Segmentations (NIfTI, zip, 1.7 MB)	*Download*	CC BY 3.0
Segmentation Features and Image Metadata (CSV, 47 kb)	*Download*	CC BY 3.0
Baseline UNet 2D Summary (PDF, 1.19 MB)	*Download*	CC BY 3.0
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Data Dictionary (DOCX, 19 kb)	*Download*	CC BY 3.0

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Collections Used in this Third Party Analyses

Below is a list of the Collections used in these analyses:

Source Data Type	Download	License
Corresponding Original CT Images from NSCLC-Radiomics (DICOM, 402 subjects, 24 GB)	*Download* (Download requires NBIA Data Retriever)	CC BY 3.0

- NSCLC-Radiomics

Detailed Description

Detailed Description

All NIfTI files have been compressed for convenience (.nii.gz)

Note: These segmentations use the RPI orientation, but the original DICOM files are oriented using the RAI convention. As a result, some tools such as ITK-SNAP will not render the segmentations in the correct orientation when visualized. The authors of these data suggest using software like Mango (http://ric.uthscsa.edu/mango/) or to convert to DICOM files to NIfTI with software like dcm2niix (https://github.com/rordenlab/dcm2niix) to address this issue.

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Data Citation

Kiser, K.J., Ahmed, S., Stieb, S.M., Mohamed, A.S.R., Elhalawani, H., Park, P.Y.S., Doyle, N.S., Wang, B.J., Barman, A., Fuller, C.D., Giancardo, L. (2020). *Data from the* **Thoracic Volume and Pleural Effusion Segmentations in Diseased Lungs for Benchmarking Chest CT Processing Pipelines (PleThora)** [Data set]. The Cancer Imaging Archive. https://doi.org/10.7937/tcia.2020.6c7y-gq39 .

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Publication Citation

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PMID: 34027588 PMCID: PMC8329111
(2020 medRxiv preprint doi): https://doi.org/10.1101/2020.05.14.20102103.

TCIA Citation

Clark, K., Vendt, B., Smith, K., Freymann, J., Kirby, J., Koppel, P., Moore, S., Phillips, S., Maffitt, D., Pringle, M., Tarbox, L., & Prior, F. (2013). **The Cancer Imaging Archive (TCIA): Maintaining and Operating a Public Information Repository.** In Journal of Digital Imaging (Vol. 26, Issue 6, pp. 1045–1057). Springer Science and Business Media LLC. https://doi.org/10.1007/s10278-013-9622-7 PMCID: PMC3824915

In addition to the dataset citation above, please be sure to also cite the following if you utilize these data in your research:

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Aerts, H. J. W. L., Wee, L., Rios Velazquez, E., Leijenaar, R. T. H., Parmar, C., Grossmann, P., Carvalho, S., Bussink, J., Monshouwer, R., Haibe-Kains, B., Rietveld, D., Hoebers, F., Rietbergen, M. M., Leemans, C. R., Dekker, A., Quackenbush, J., Gillies, R. J., & Lambin, P. (2019). **Data From NSCLC-Radiomics (Version 4) [Data set].** The Cancer Imaging Archive. https://doi.org/10.7937/K9/TCIA.2015.PF0M9REI

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Versions

Version 3 (Current): Updated 2020/07/28

Data Type	Download all or Query/Filter
Corresponding Original CT Images (DICOM) from NSCLC-Radiomics (24 GB)	Download
Thoracic Segmentations (NIfTI, 26.9 MB)	Download
Pleural Effusion Segmentations (NIfTI, 1.7 MB)	Download
Segmentation Features and Image Metadata (CSV)	Download
Baseline UNet 2D Summary (PDF)	blocked URL
Baseline UNet 3D Summary (PDF)	blocked URL
Data Dictionary (DOCX)	blocked URL

Version 3 changes:

2D U-Net

- Incorrectly reported the 2D U-Net achieved segmentations with Dice similarity coefficients of 0.90 and 0.94 for left and right lungs.
- The performances should be 0.94 and 0.94.

3D U-Net

- Incorrectly reported the 3D U-Net achieved segmentations with Dice similarity coefficients of 0.82 and 0.94 for left and right lungs.
- The performances should be 0.95 and 0.96.

Data Dictionary

Added *Auto-MS Thorax DSC* description.

Version 2: 2020/06/26

Data Type	Download all or Query/Filter

Corresponding Original CT Images (DICOM) from NSCLC-Radiomics (24 GB)	Download
Thoracic Segmentations (NIfTI, 26.9 MB)	Download
Pleural Effusion Segmentations (NIfTI, 1.7 MB)	Download
Segmentation Features and Image Metadata (CSV)	Download
Baseline UNet 2D Summary (PDF)	blocked URL
Baseline UNet 3D Summary (PDF)	blocked URL
Data Dictionary (DOCX)	blocked URL

Version 2 changes:

- The dataset is now named “PleThora” for “**Ple**ural effusion and **thor**acic cavity segmentations in diseased lungs.”
- All NIfTI files have been compressed for convenience (.nii à .nii.gz)
- All thoracic cavity primary reviewer segmentations have been renamed from “lungMask_edit.nii” to “[CaseID]_thor_cav_primary_reviewer.nii.gz” to more specifically identify each file’s contents and avoid confusion.
- Eighty-six thoracic cavity secondary reviewer segmentations have been added. These are named “[CaseID]_thor_cav_secondary_reviewer.nii.gz.”
- Interobserver variability analysis between primary and secondary reviewer thoracic cavity segmentations revealed four cases in which interobserver agreement was anomalously lower than all other cases. These cases were manually re-reviewed by another physician. In three cases (LUNG1-026, LUNG1-157, and LUNG1-354) it was deemed that the secondary reviewer’s segmentation excluded structures that should have been included. These were corrected. In one case (LUNG-088) it was determined that the primary reviewer segmentation included a large (400 cm3) nodal conglomerate. Our original thoracic cavity segmentation definition did not intend to include nodal conglomerates, so for consistency’s sake we corrected the primary reviewer segmentation accordingly. However, the segmentation with the nodal conglomerate is still valuable, so we provide it as well and name it “LUNG1-088_thor_cav_primary_reviewer_with_nodal_conglomerate.nii”
- We manually reviewed the pleural effusion segmentations of the primary physician reviewer and determined that in many cases the reviewer had not been sufficiently careful. Therefore, all 78 primary reviewer segmentations were re-reviewed by another physician and corrected as necessary. They are now re-submitted as “[CaseID]_effusion_first_reviewer.nii.gz”
- Seventy-eight pleural effusion secondary reviewer segmentations have been added. These are named “[CaseID]_effusion_second_reviewer.nii.gz.”
- Fifteen pleural effusion tertiary reviewer segmentations have been added. These are named “[CaseID]_effusion_third_reviewer.nii.gz.”
- We add two documents that describe baseline performances for 2D and 3D U-Net segmentation algorithms and define a reproducible train/test split.
- Data Dictionary: we provide a data dictionary to describe the meanings of column names in the “Thorax and Pleural Effusion Segmentation Metadata” spreadsheet.

Version 1: 2020/04/03

Data Type	Download all or Query/Filter
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Pleural Effusion Segmentations (NIfTI, 5.3 MB zipped, 4.9 GB uncompressed)	Download
Segmentation Features and Image Metadata (CSV)	Download
Corresponding Original CT Images (DICOM) from NSCLC-Radiomics (24 GB)	Download