Lung Cancer Risk Prediction

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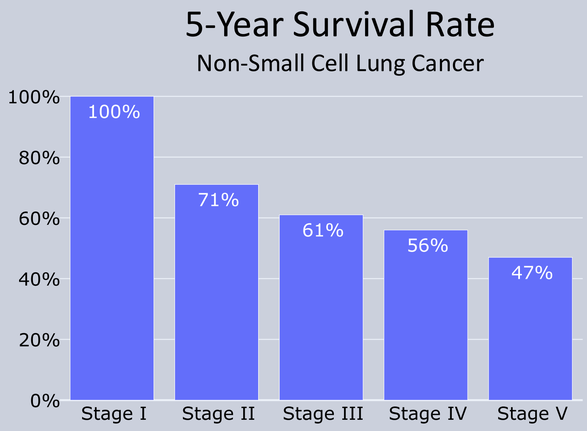
Background and Motivation

Lung cancer is the leading cause of cancer-related mortality worldwide

Deep Learning approaches that only consider imaging are fundamentally limited [1].

Lung cancer is heavily contextualized through non-imaging risk factors.

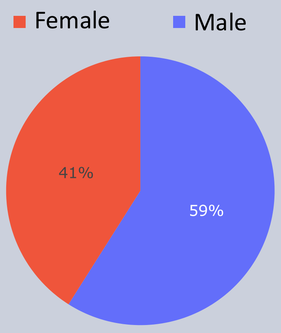
➡ **Multimodal models**



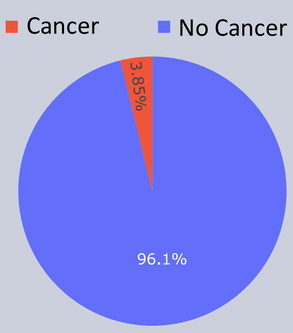
National Lung Screening Trial (NLST) Dataset

26,722 total patients over **55 years** old

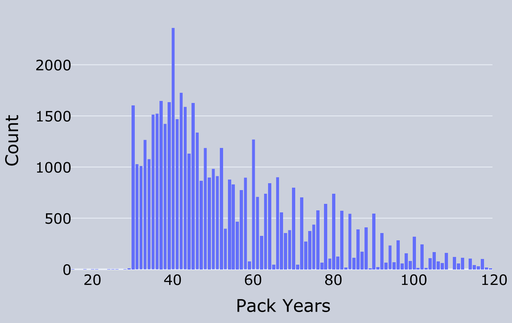
Gender Distribution



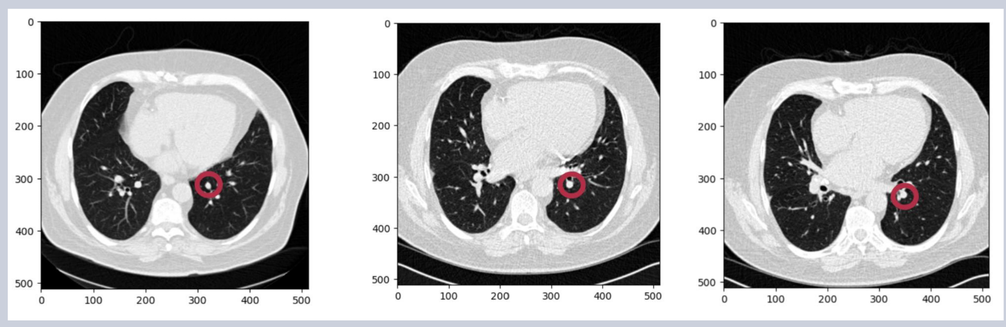
Cancer Cases



Smoking History



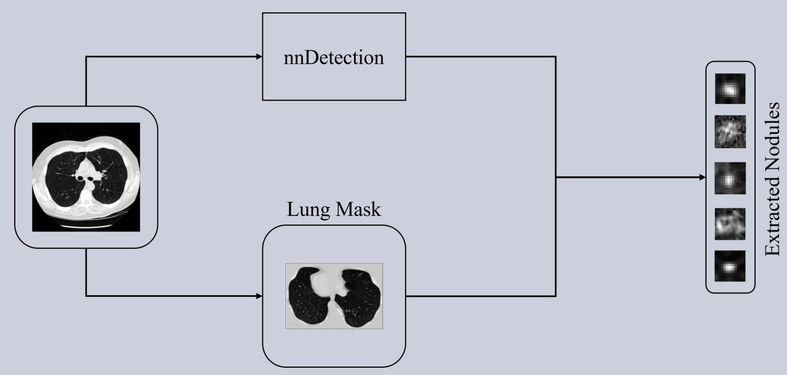
CT Slices and Nodules



Method

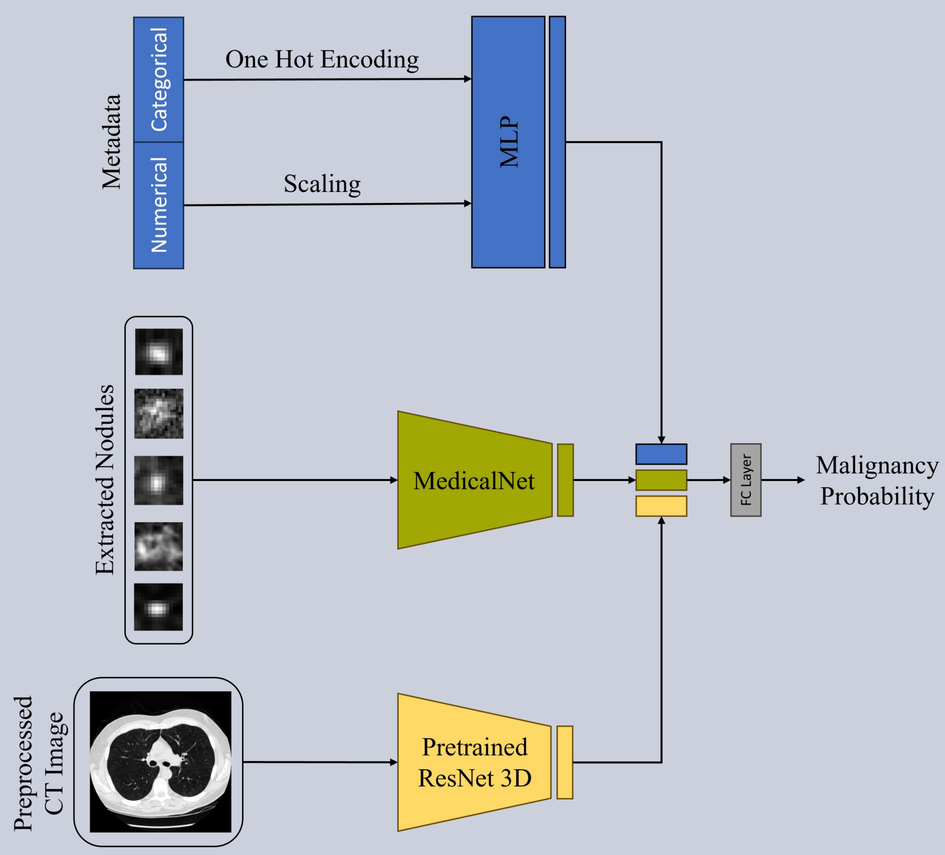
Preprocessing

In our preprocessing phase, we employ nnDetection [2], utilizing a pre-trained model on the Luna16 dataset to identify the five most confidently detected nodules within a scan.



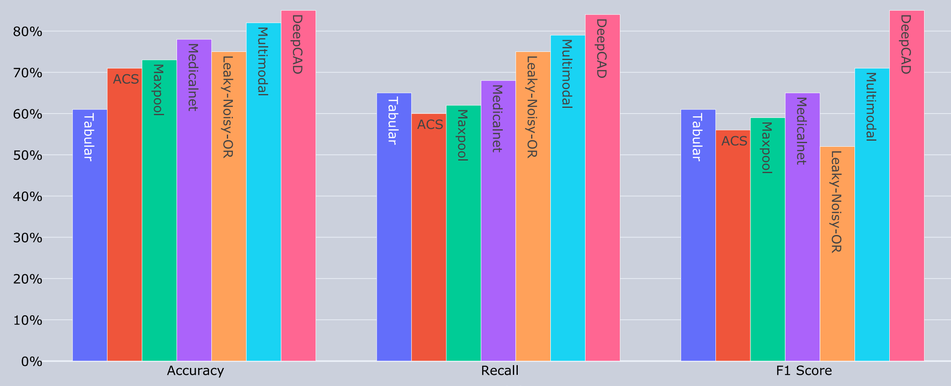
Multimodal Model Architecture

- Integrate nodule-level data with lung-level and clinical metadata, to enhance predictive accuracy
- Feature extraction from nodules and lung images using MedicalNet [3], a 3D-ResNet pre-trained on medical imagery
- Dataset's higher proportion of negative cases: weighted cross-entropy loss to prioritize mitigating false negatives during network training



Results

	Accuracy	Precision	Recall	F1
Nodules (ACSConv [4])	0.71	0.54	0.60	0.56
Nodules (Maxpool)	0.73	0.57	0.62	0.59
Nodules (MedicalNet [3])	0.78	0.63	0.68	0.65
Nodules (Leaky Noisy-OR [5])	0.75	0.40	0.75	0.52
Tabular Data/Metadata	0.61	0.59	0.65	0.61
Multimodal Approach	**0.82**	**0.69**	**0.79**	**0.71**
DeepCAD [6]	0.85	0.84	0.87	0.85



Conclusion / Main Findings

- The **combination of different levels of features**, including clinical metadata and imaging data at the lung and nodule level, provides a good estimation of malignancy
- The predictive capability of our **multimodal approach** is superior compared to utilizing the data sources independently
- Our analysis reveals **superior performance when employing a feature extractor pre-trained specifically on lung CTs** compared to one pre-trained on alternative domains.

References

[1] D. Ardila, et al. "End-to-end lung cancer screening with three-dimensional deep learning on low-dose chest computed tomography." (2019).
[2] M. Baumgartner, et al. "nnDetection: a self-configuring method for medical object detection.“ (2021).
[3] S. Chen, et al. "Med3d: Transfer learning for 3d medical image analysis." (2019).
[4] J. Yang, et al. "Reinventing 2d convolutions for 3d images." (2021).
[5] F. Liao, et al. "Evaluate the malignancy of pulmonary nodules using the 3-d deep leaky noisy-or network." (2019).
[6] S. Aslani, et al. "Enhancing cancer prediction in challenging screen-detected incident lung nodules using time-series deep learning.“(2022).

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