END TO END MODEL FOR NODULE DETECTION AND CHARACTERIZATION IN LUNG CANCER SCREENING: PERFORMANCES AND SUBPOPULATION ANALYSIS

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BACKGROUND

Detection and characterization through appropriate malignancy risk evaluation of pulmonary nodules during lung cancer screening remains a difficult and time consuming task. Here we present the performances and subpopulation analysis of a computer-aided detection and characterization (CADe/CADx) AI model developed to aid lung cancer screening standard of care.

METHODS

The model was designed using 10872 patients from the NLST and LIDC. Benign and cancer diagnosis was considered as 1 year stability follow up and histopathology proof respectively. The model consists first in an ensembling of 3D-CNN detection models that localize pulmonary nodules, second is an ensembling of 3D-CNN providing malignancy risk for all the detected nodules. Given an LDCT scan in input, the model predicts the location, segmentation, and malignancy probability of each nodule. The entire test set contained 2163 NLST patients (136 cancer, 2027 benign). Patients were stratified according to nodule standard mean diameter measure, margins and attenuations derived from the highest risk nodule according to the model output.

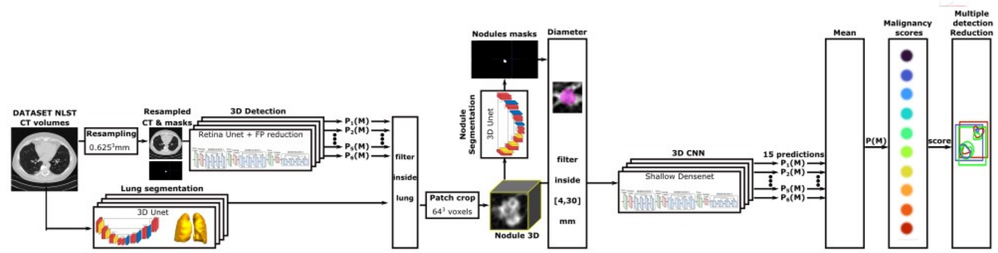

Figure 1: Presentation of the global workflow of the CADe/Cadx for lesion prediction, with CADe 3D CNN detection and lung segmentation on the left, and with nodule segmentation and CADx on the right. The CADx ensembles 15 different 3D CNN models [2]. It is followed by a discretization module into 10 malignancy scores (not used here) and a module of redundant detection reduction.

RESULTS

On the NLST test set the patient level AUC-ROC was 0.952, 95% CI [0.933 0.968]. Considering a subset of nodules in the NLST ground truth localized by our radiologists (n =3952, 145 malignant, 3807 benign), our model with an AUC-ROC of 0.987 [0.981 0.991] at nodule level significantly outperforms the NLST Brock model[1] which displayed an AUC-ROC 0.971 [0.961 0.979] (unpaired one-sided Welch t test p<<0.05, 5000 bootstraps samples) on the same dataset. When looking at the size subclasses the AUC was 0.965 [0.899-1] for nodules 4-10mm, 0.963 [0.934-0.991] for 10-20mm, and 0.899 [0.821-0.914] for 20-30mm . AUC for spiculated and non-spiculated nodules were 0.943 [0.832-1] and 0.921 [0.874-0.969] respectively. When looking at the solid and non-solid nodule subclasses AUC were 0.932 [0.869-0.995] and 0.924 [0.849-0.999].

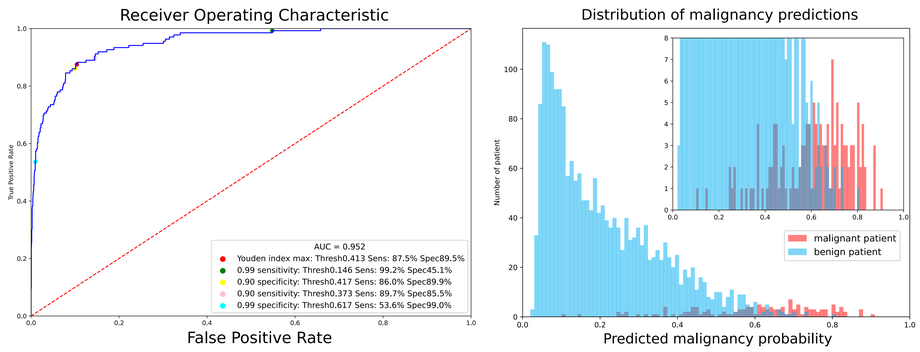

Figure 2: (Left) The ROC curve at patient level and **(Right)** the distribution of malignancy prediction of our CADex model on the 2163 NLST patients (136 cancer, 2027 benign) test set with an enlarged view on the low occurrence values of the distribution.

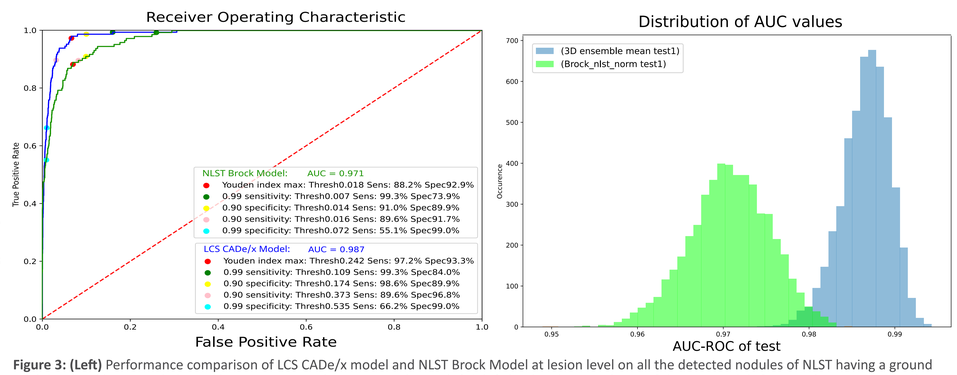

Figure 3: (Left) Performance comparison of LCS CADe/x model and NLST Brock Model at lesion level on all the detected nodules of NLST having a ground truth localized by our radiologists (n =3952, 145 malignant, 3807 benign). **(Right)** the distribution of AUC of the two models for 5000 bootstraps samples.

CONCLUSIONS

The model exhibits robust performance in detecting and predicting the malignancy risk of nodules present in lung cancer screening populations and significantly outperforms NLST Brock model without requiring clinician's nodule detection and feature assessment as Brock model does. Importantly, the model's performance was consistent across key characteristics highlighting its potential to improve patient management in screening programs and early cancer diagnosis. The model's reliable risk evaluation could aid clinicians in optimizing their clinical routine and the clinical management of patients.

BIBLIOGRAPHY

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