Deep Learning for Automated Quantification of Tumor Phenotypes

HARVARD MEDICAL SCHOOL

BRIGHAM AND WOMEN'S HOSPITAL

DANA-FARBER CANCER INSTITUTE

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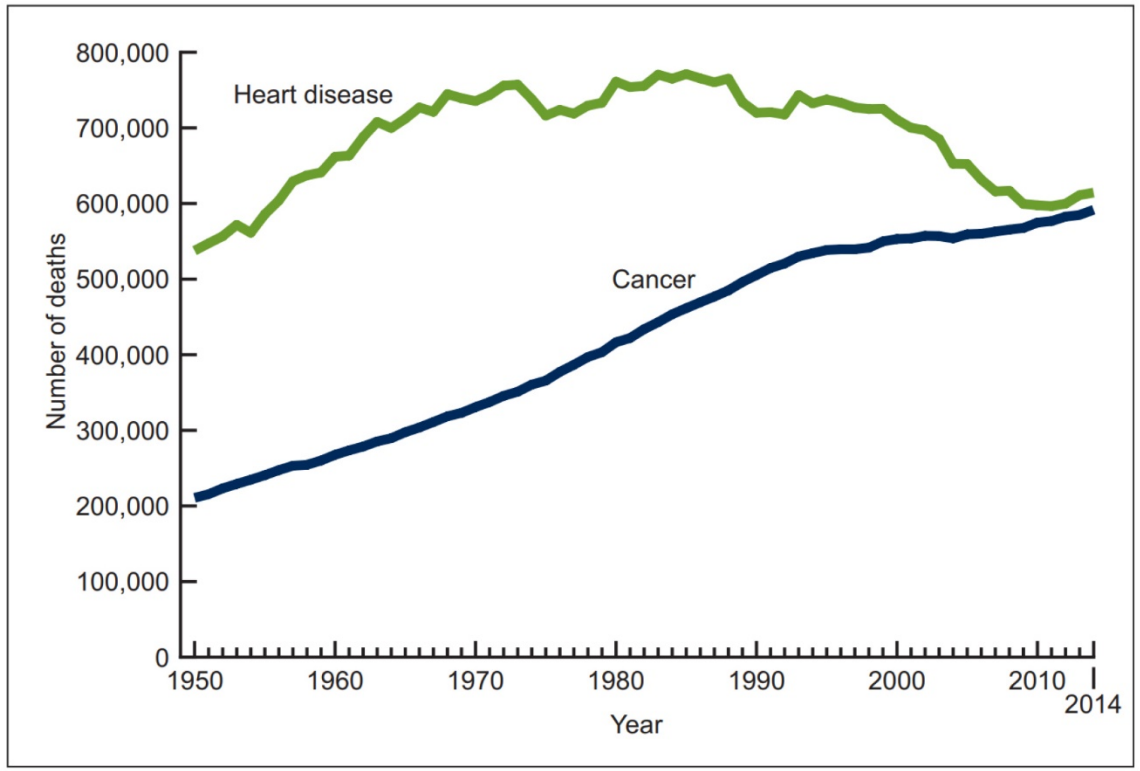
Computed Tomography II - Imaging Scientific Session
AAPM 2018 - Wednesday, 8/1/2018 10:15 AM - 12:15 PM

Cancer

Figure 1. Number of deaths due to heart disease and cancer: United States, 1950–2014



Centers for Disease Control and Prevention

Changes in the Leading Cause of Death: Recent Patterns in Heart Disease and Cancer Mortality
https://www.cdc.gov/nchs/data/databriefs/db254.pdf

Lung Cancer Staging

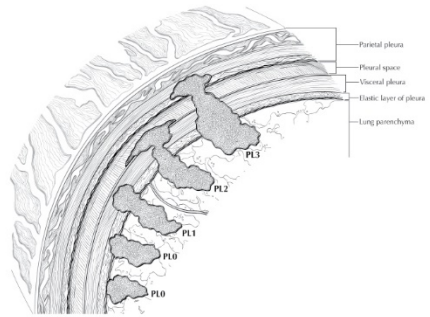
Classifications

Primary Tumor (T) Classification

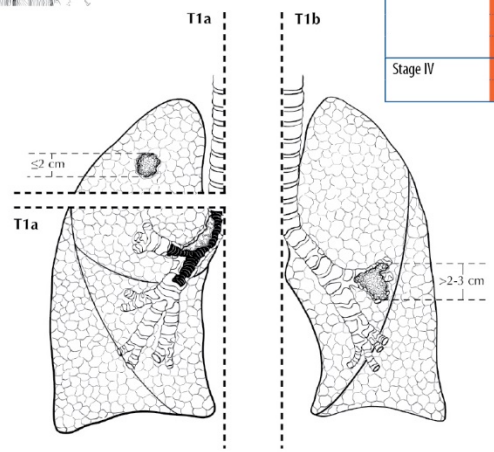
- **TX** Primary tumor cannot be assessed, or tumor proven by the presence of malignant cells in sputum or bronchial washings but not visualized by imaging or bronchoscopy
- **T0** No evidence of primary tumor
- **Tis** Carcinoma in situ
- **T1** Tumor 3 cm or less in greatest dimension, surrounded by lung or visceral pleura, without bronchoscopic evidence of invasion more proximal than the lobar bronchus
- **T1a** Tumor 2 cm or less in greatest dimension
- **T1b** Tumor more than 2 cm but 3 cm or less in greatest dimension
- **T2** Tumor more than 3 cm but 7 cm or less or tumor with any of the following features (T2 tumors with these features are classified T2a if 5 cm or less): involves main bronchus, 2 cm or more distal to the carina; invades visceral pleura (PL1 or PL2); associated with atelectasis or obstructive pneumonitis that extends to the hilar region but does not involve the entire lung
- **T2a** Tumor more than 3 cm but 5 cm or less in greatest dimension
- **T2b** Tumor more than 5 cm but 7 cm or less in greatest dimension
- **T3** Tumor more than 7 cm or one that directly invades any of the following: parietal pleural (PL3), chest wall (including superior sulcus tumors), diaphragm, phrenic nerve, mediastinal pleura, parietal pericardium; or tumor in the main bronchus less than 2 cm distal to the carina[1] but without involvement of the carina; or associated atelectasis or obstructive pneumonitis of the entire lung or separate tumor nodule(s) in the same lobe
- **T4** Tumor of any size that invades any of the following: mediastinum, heart, great vessels, trachea, recurrent laryngeal nerve, esophagus, vertebral body, carina, separate tumor nodule(s) in a different ipsilateral lobe

Distant Metastasis (M) Classification

- **M0** No distant metastasis
- **M1** Distant metastasis
- **M1a** Separate tumor nodule(s) in a contralateral lobe, tumor with pleural nodules or malignant pleural (or pericardial) effusion
- **M1b** Distant metastasis (in extrathoracic organs)

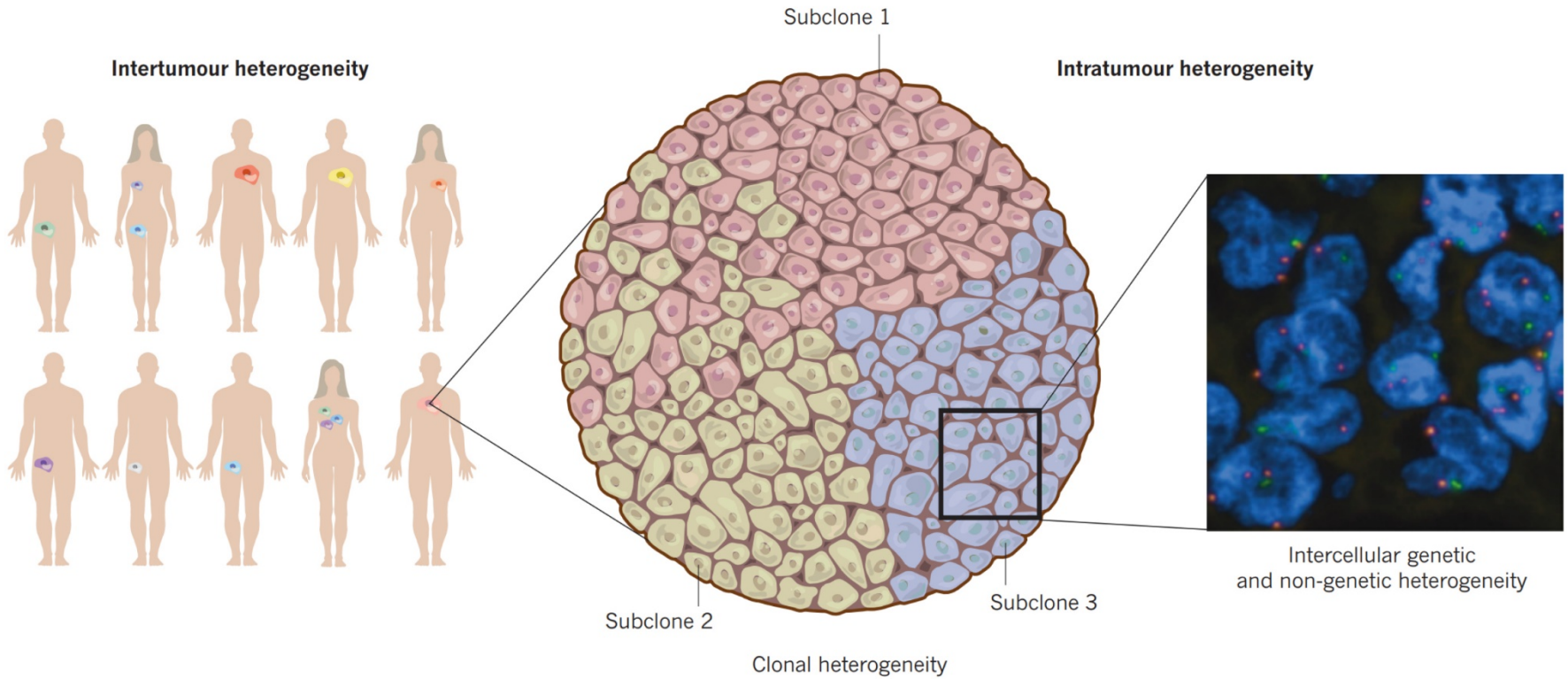


ANATOMIC STAGE/PROGNOSTIC GROUPS			
Occult Carcinoma	TX	N0	M0
Stage 0	Tis	N0	M0
Stage IA	T1a	N0	M0
	T1b	N0	M0
Stage IB	T2a	N0	M0
Stage IIA	T2b	N0	M0
	T1a	N1	M0
	T1b	N1	M0
	T2a	N1	M0
Stage IIB	T2b	N1	M0
	T3	N0	M0
Stage IIIA	T1a	N2	M0
	T1b	N2	M0
	T2a	N2	M0
	T2b	N2	M0
	T3	N1	M0
	T3	N2	M0
	T4	N0	M0
	T4	N1	M0
Stage IIIB	T1a	N3	M0
	T1b	N3	M0
	T2a	N3	M0
	T2b	N3	M0
	T3	N3	M0
	T4	N2	M0
	T4	N3	M0
Stage IV	Any T	Any N	M1a
	Any T	Any N	M1b



https://cancerstaging.org/references-tools/quickreferences/Pages/default.aspx

Intra-tumor Heterogeneity

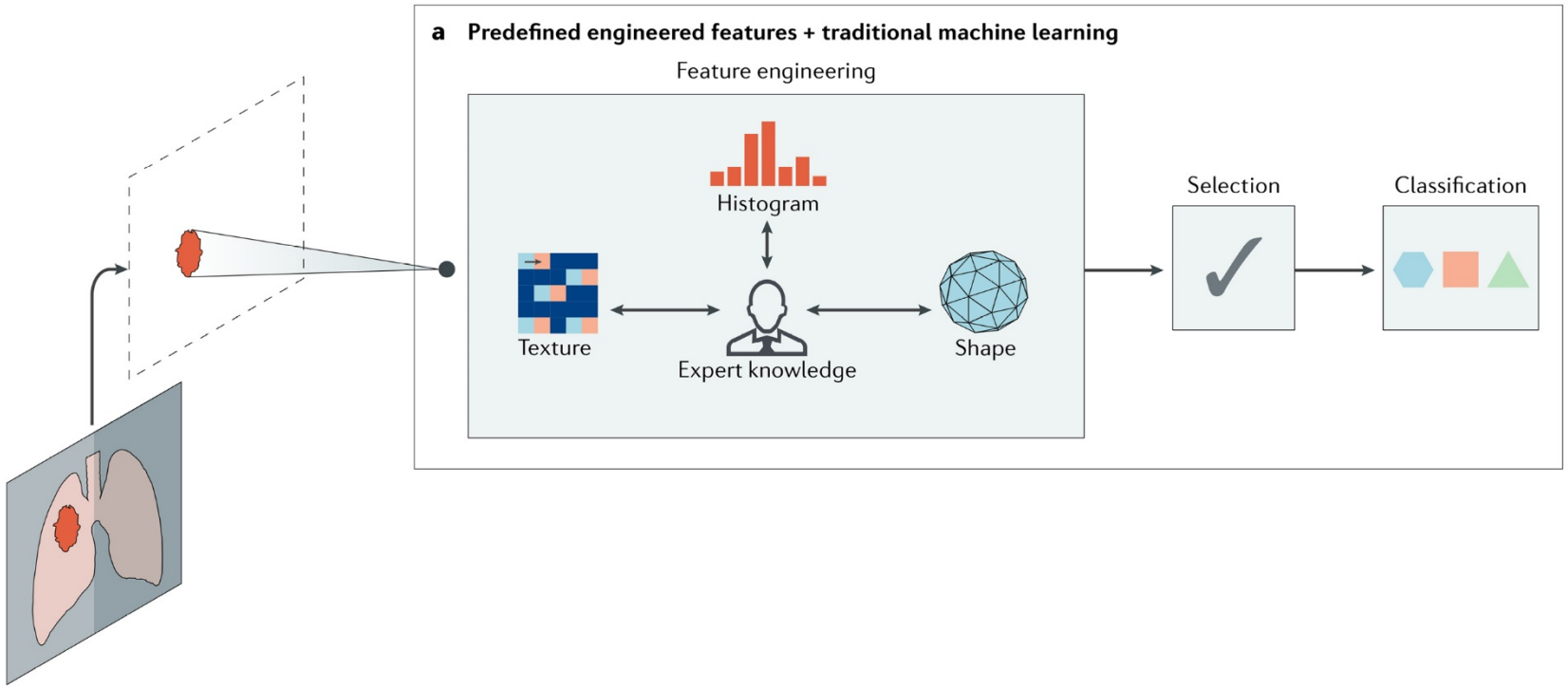


Rebecca A Burrell, Nicholas McGranahan, Jiri Bartek, and Charles Swanton

The Causes and Consequences of Genetic Heterogeneity in Cancer Evolution

Nature - 2013

Artificial Intelligence Methods in Medical Imaging



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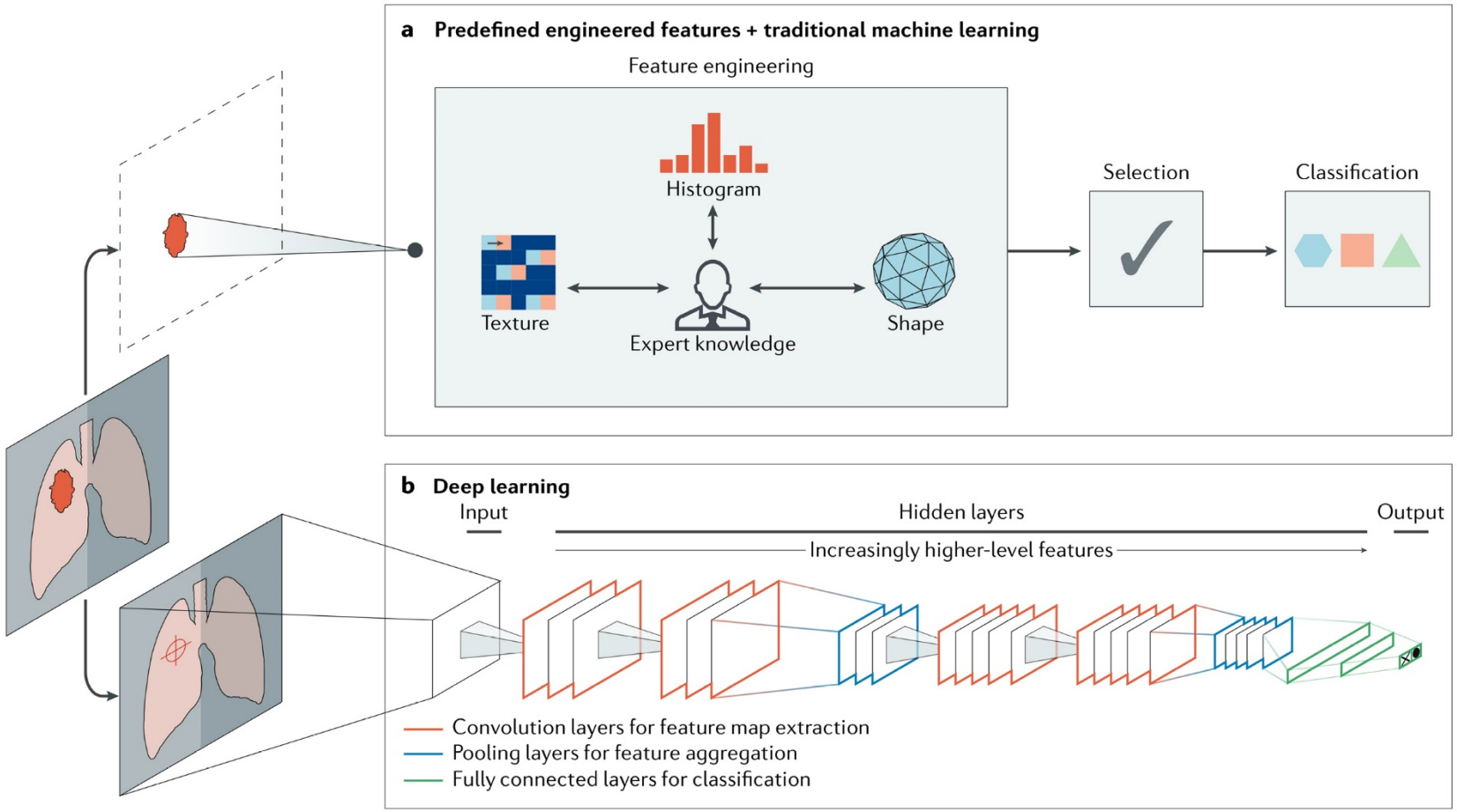
Artificial Intelligence in Radiology

Nature Reviews Cancer - 2018

Artificial Intelligence Methods in Medical Imaging



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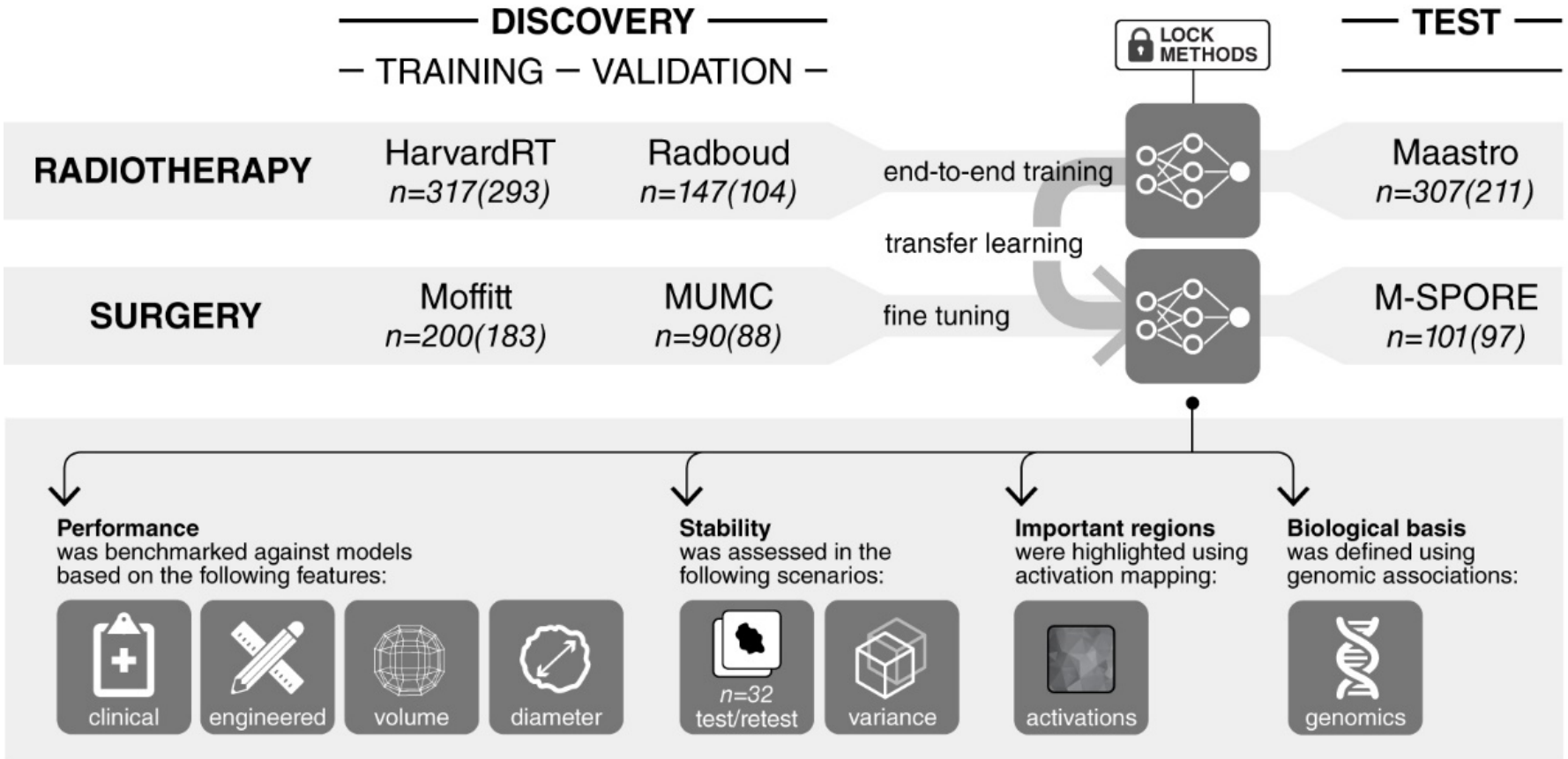
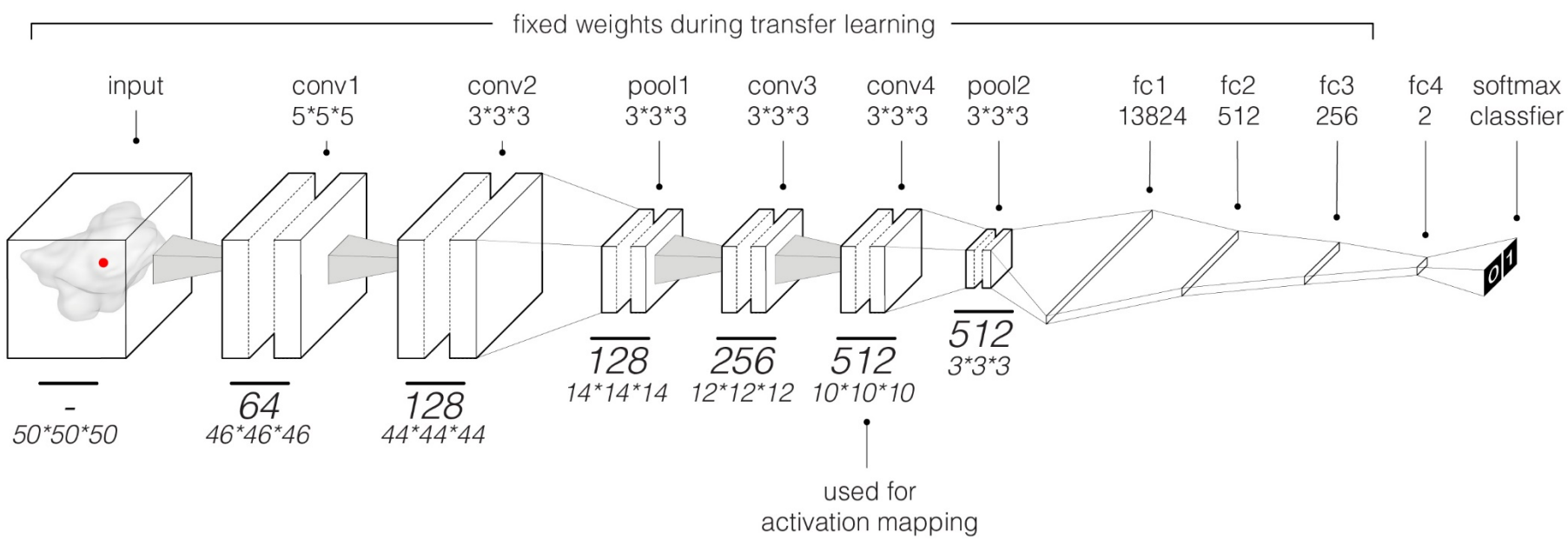
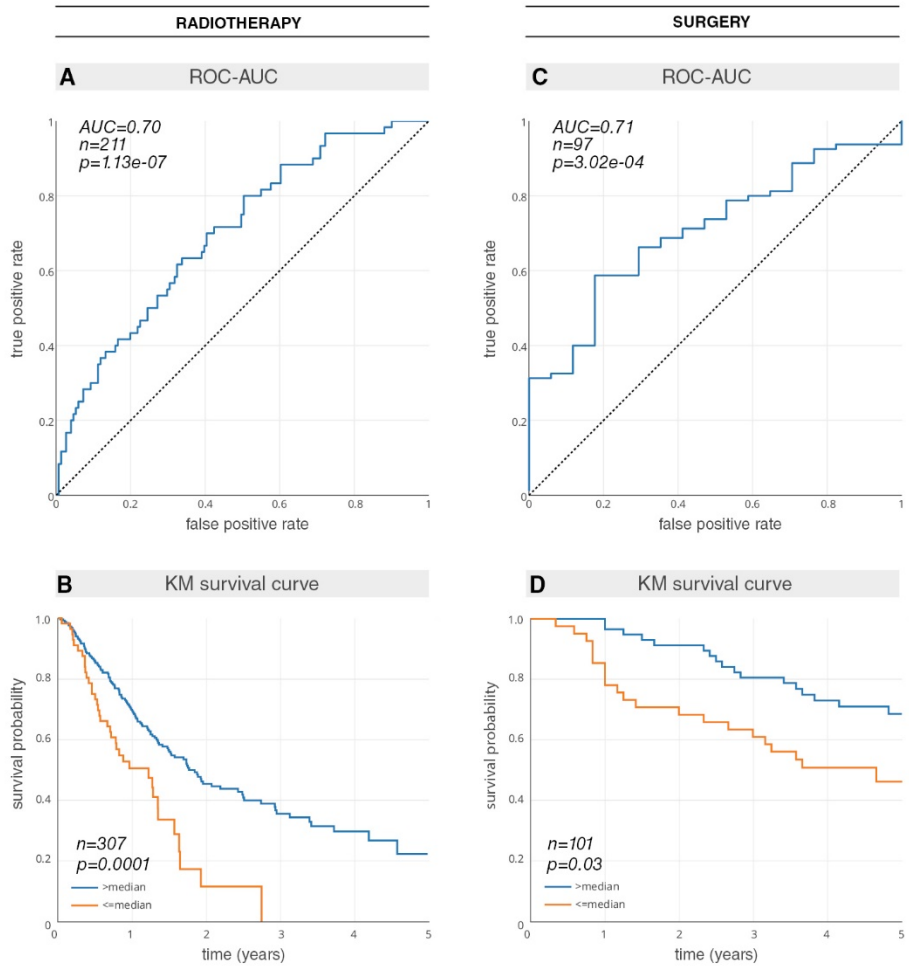
Analytical Setup



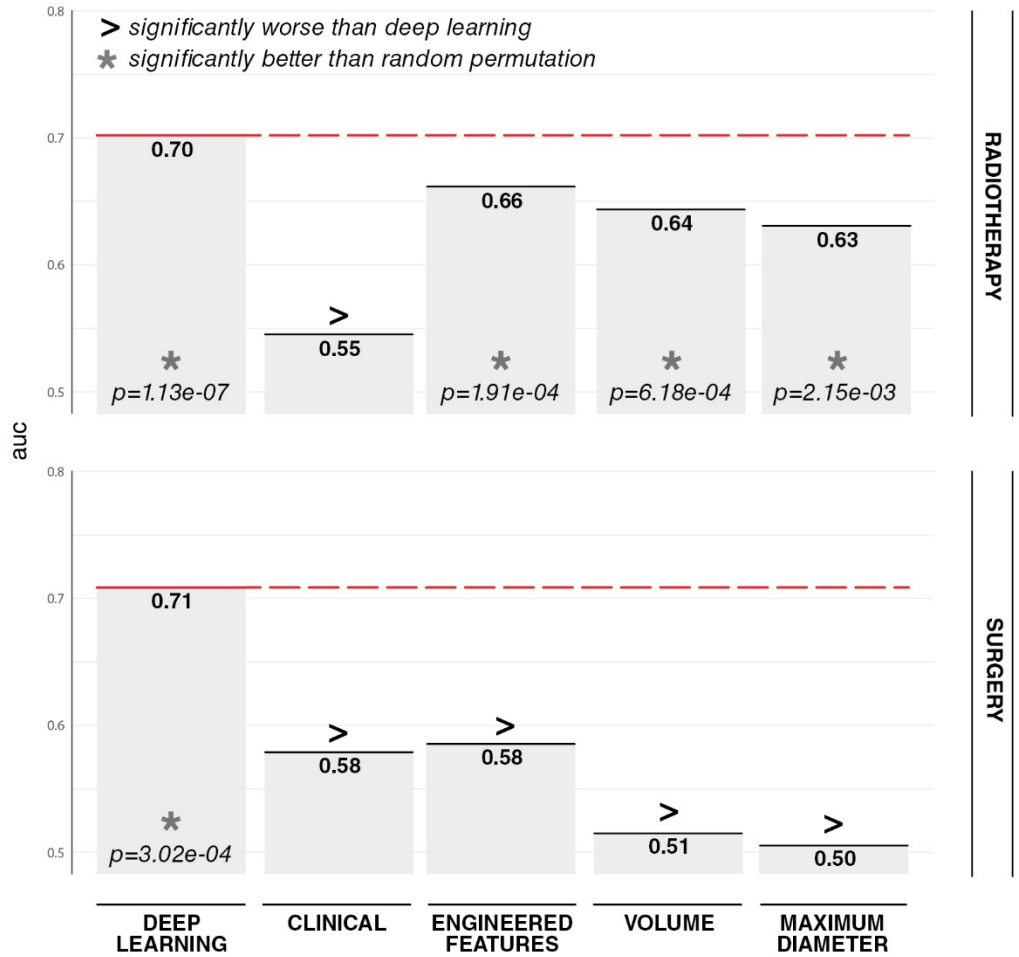
Architecture



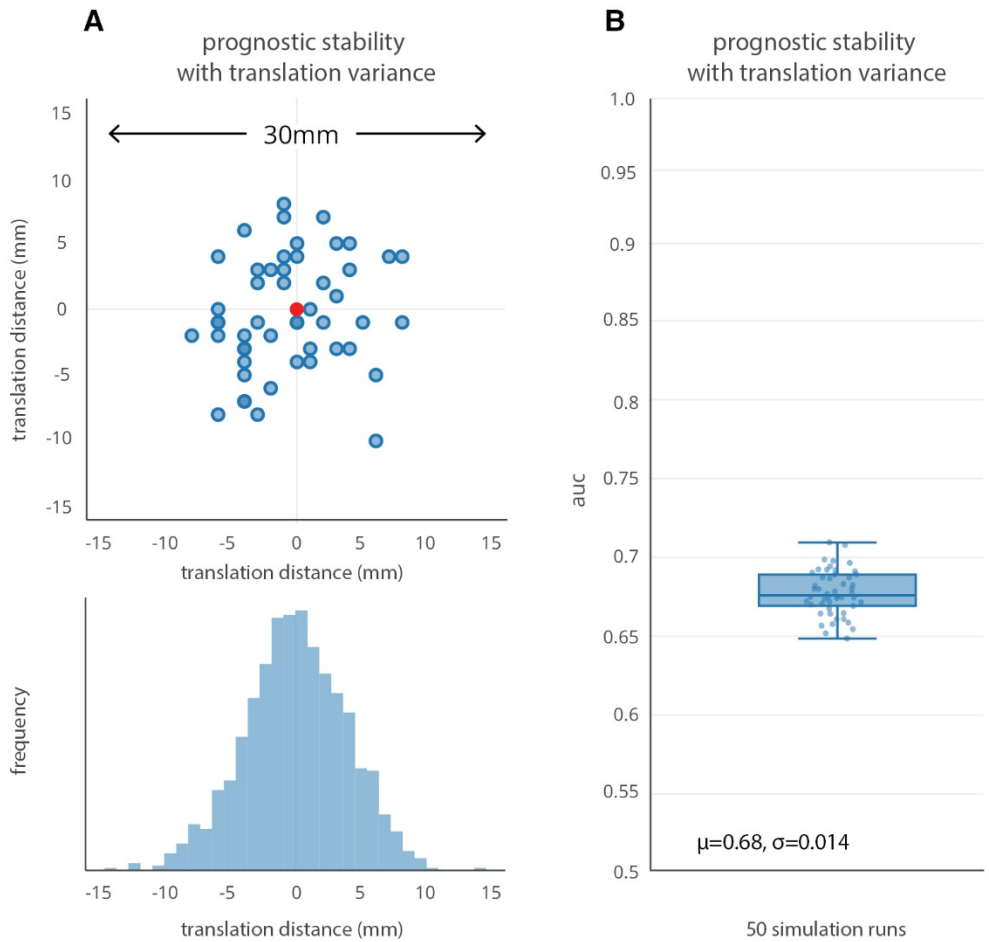
Prognostic Signal



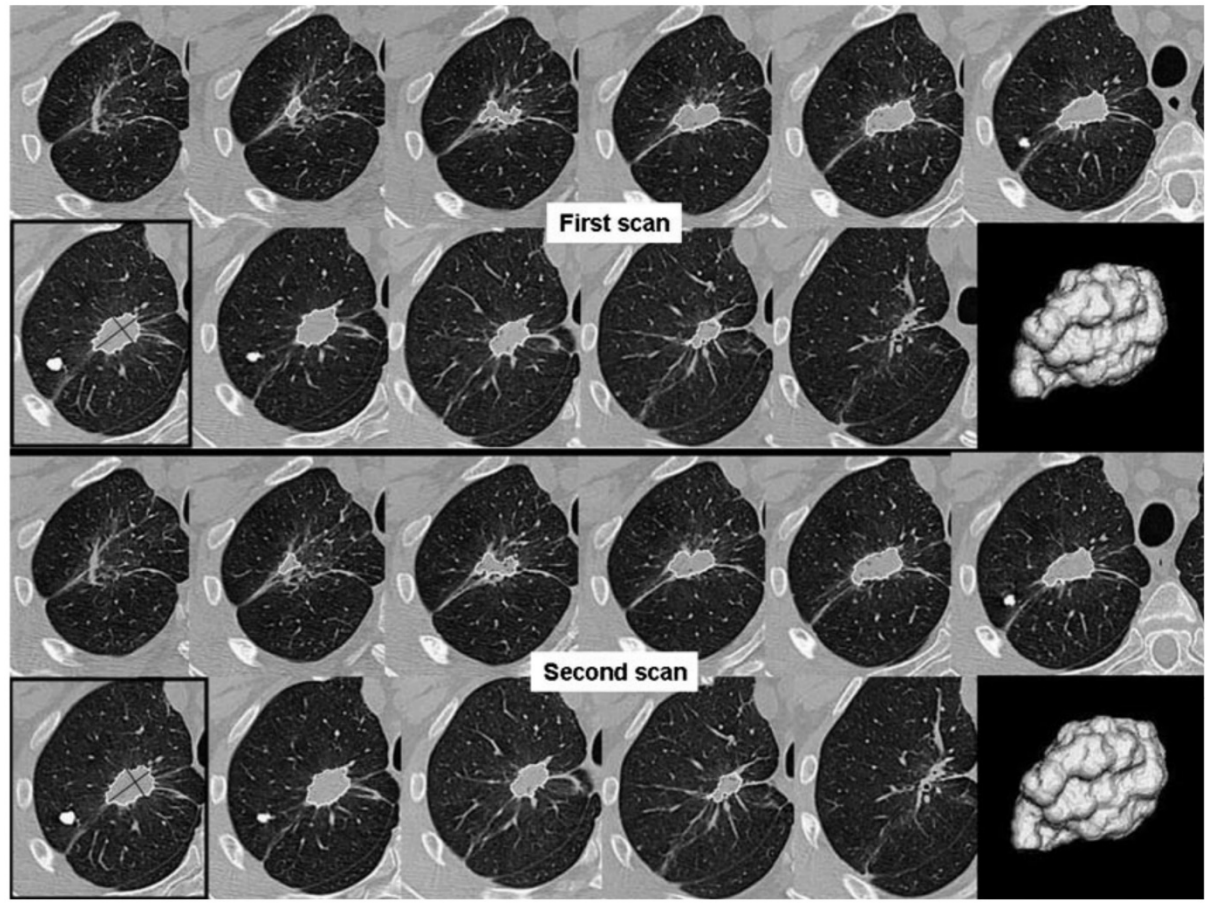
Benchmarking



Input Stability



Test-Retest Stability

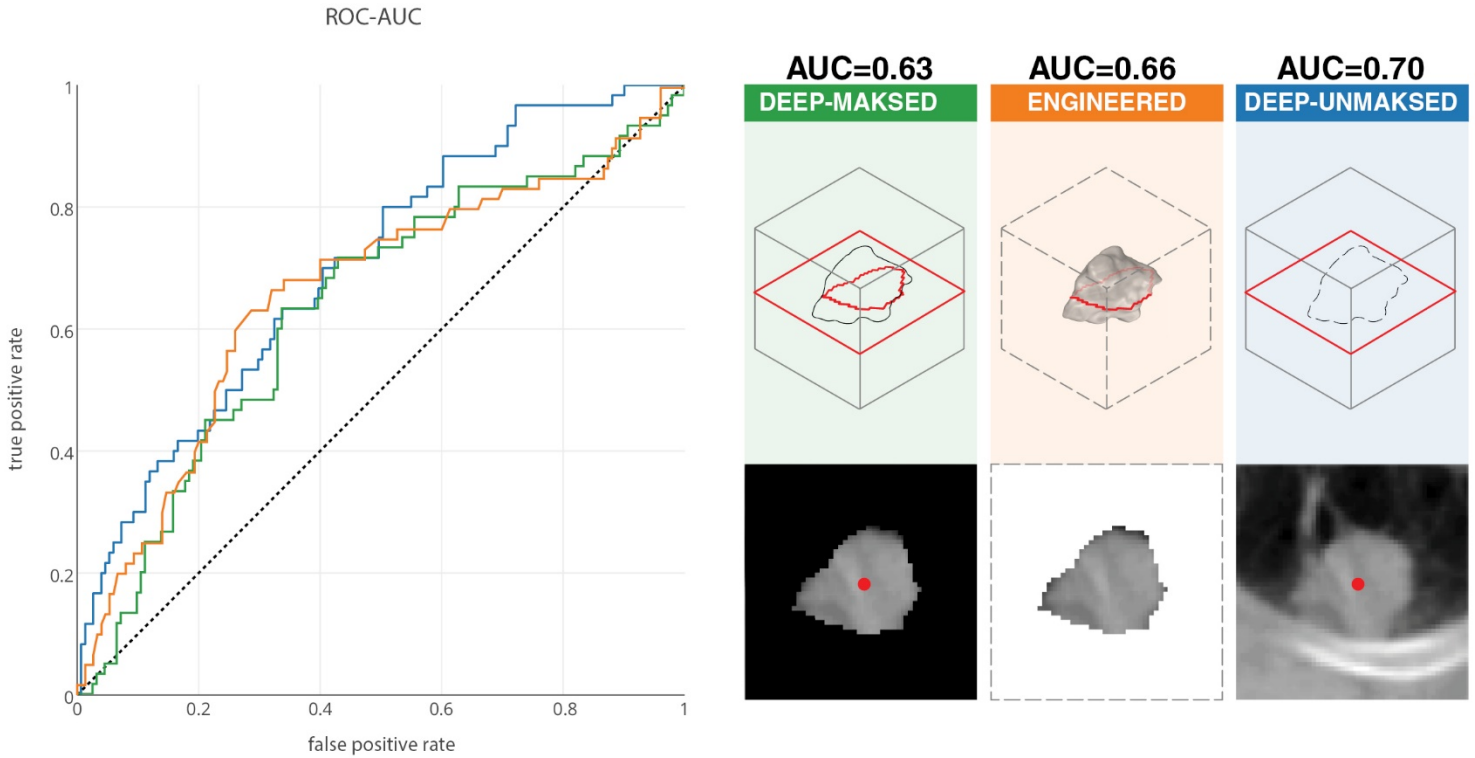


Binsheng Zhao, Leonard P. James, Chaya S. Moskowitz, Pingzhen Guo, Michelle S. Ginsberg, Robert A. Lefkowitz, Yilin Qin, Gregory J. Riely, Mark G. Kris & Lawrence H. Schwartz

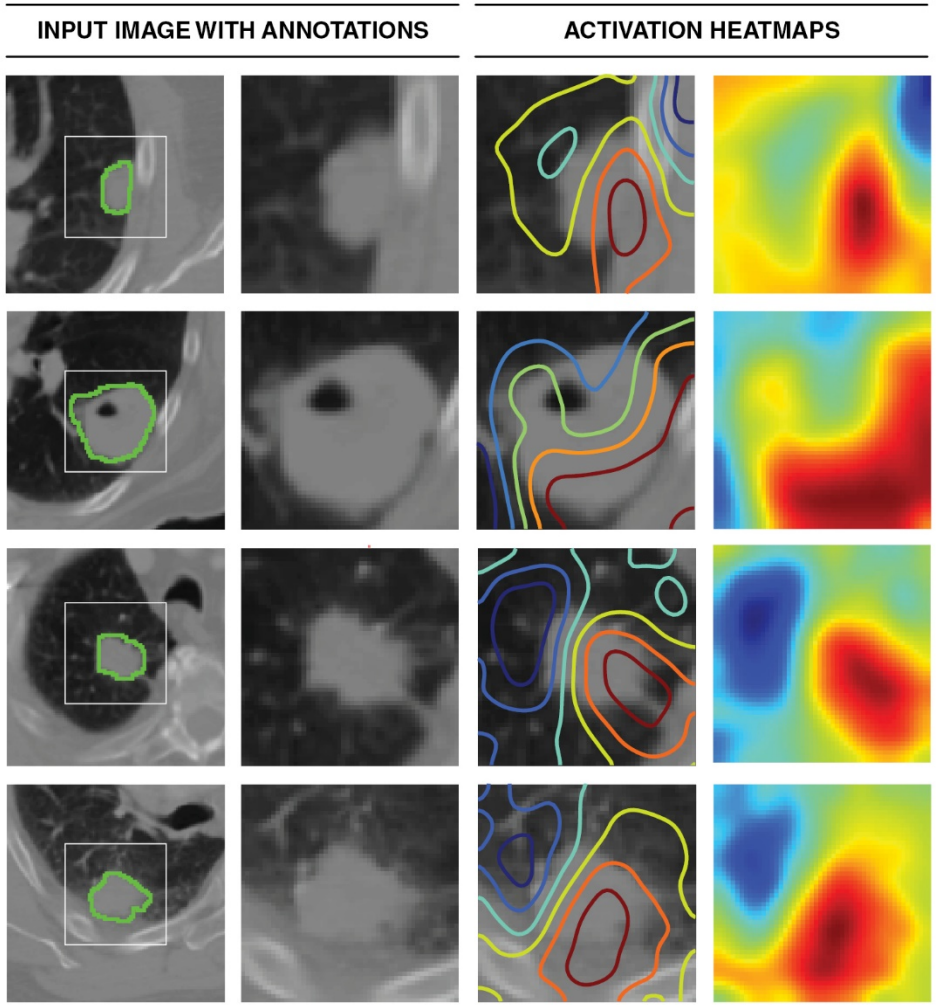
Evaluating Variability in Tumor Measurements from Same-day Repeat CT Scans of Patients with Non–Small Cell Lung Cancer

Radiology - 2009

Evaluating the Prognostic Value of Tumor-Surrounding Tissue



Activation Mapping



Thank you!