



HARVARD
MEDICAL SCHOOL

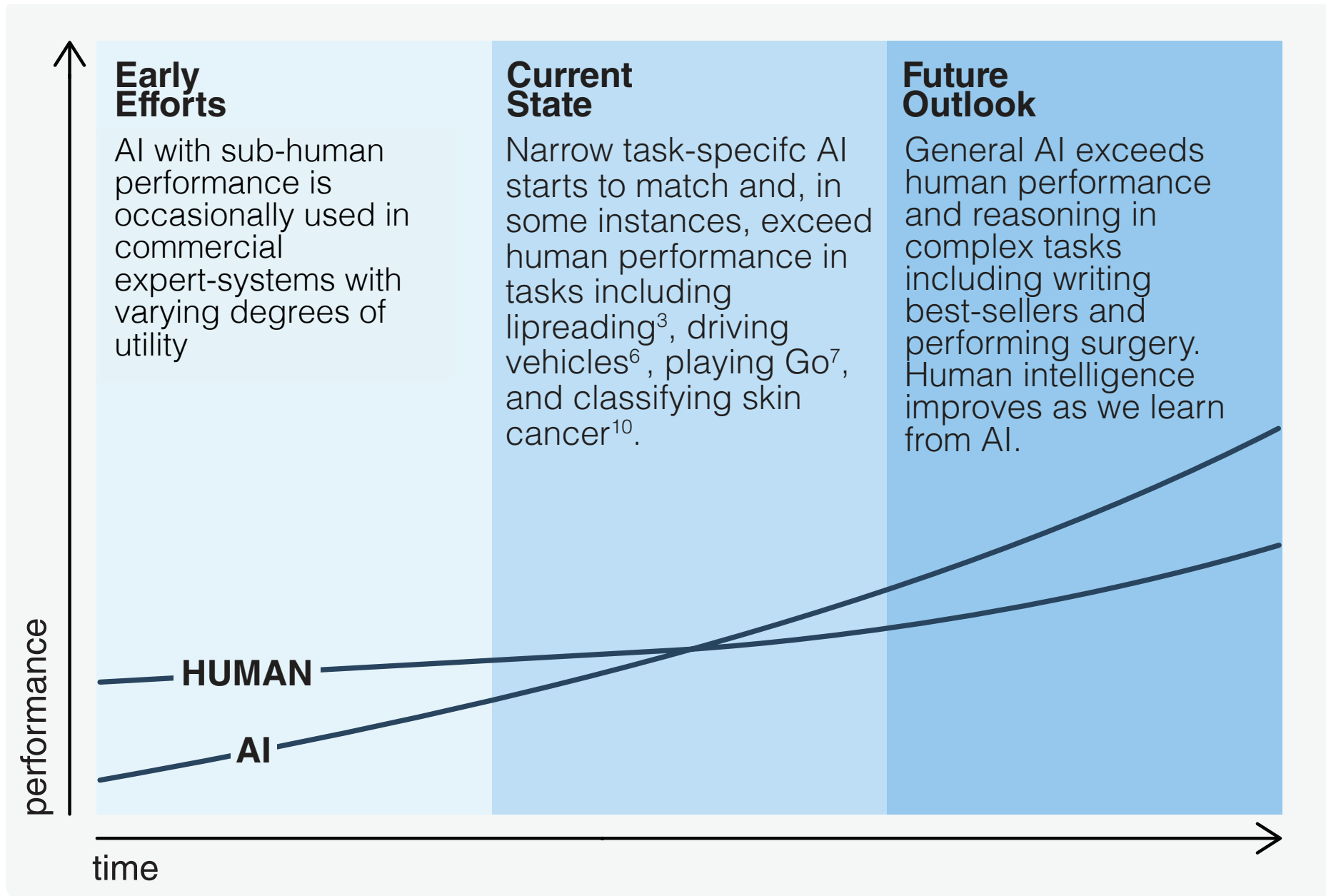
Deep Learning in Cancer Imaging

Hugo Aerts

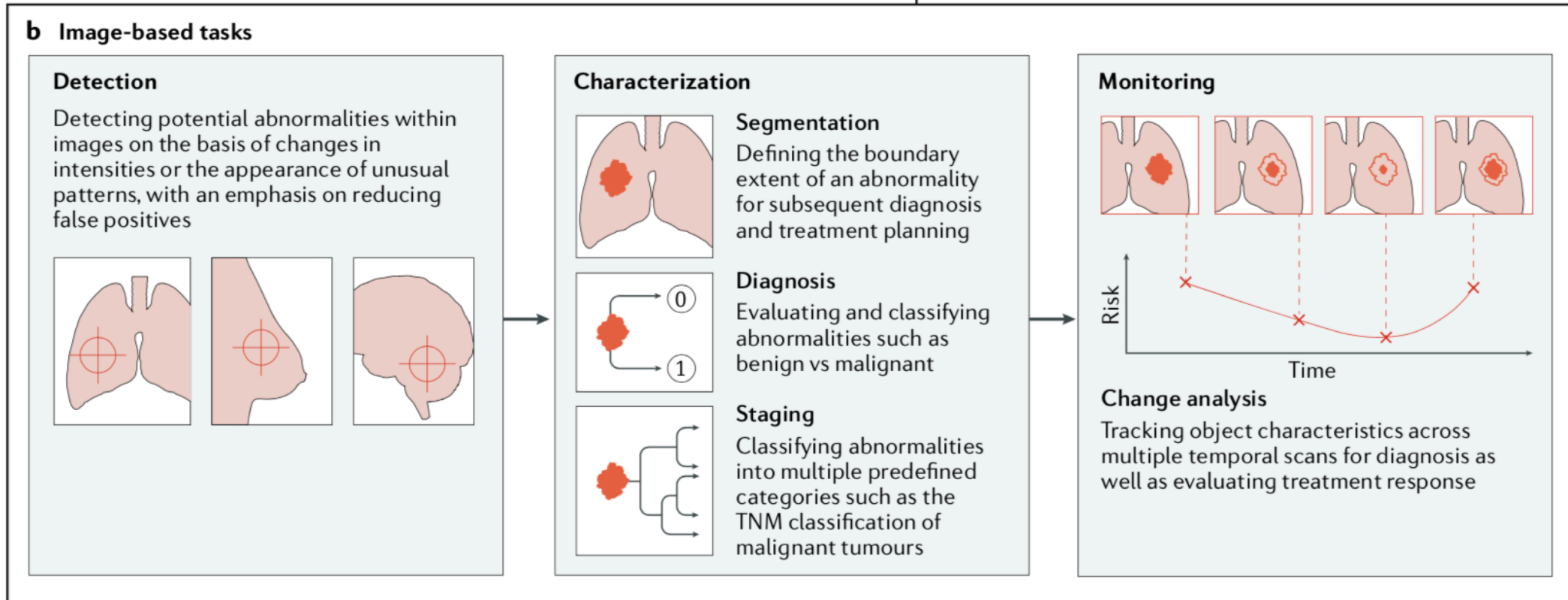
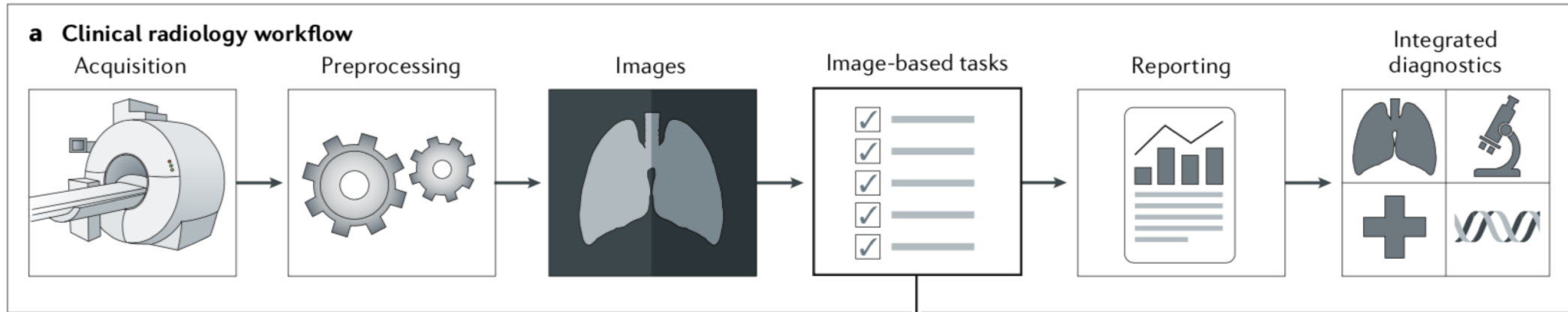
Director, Computational Imaging and Bioinformatics Lab (CIBL)
Dana-Farber Cancer Institute & Brigham and Women's Hospital
Associate Professor at Harvard Medical School



Artificial Intelligence (AI) versus human performance for various tasks

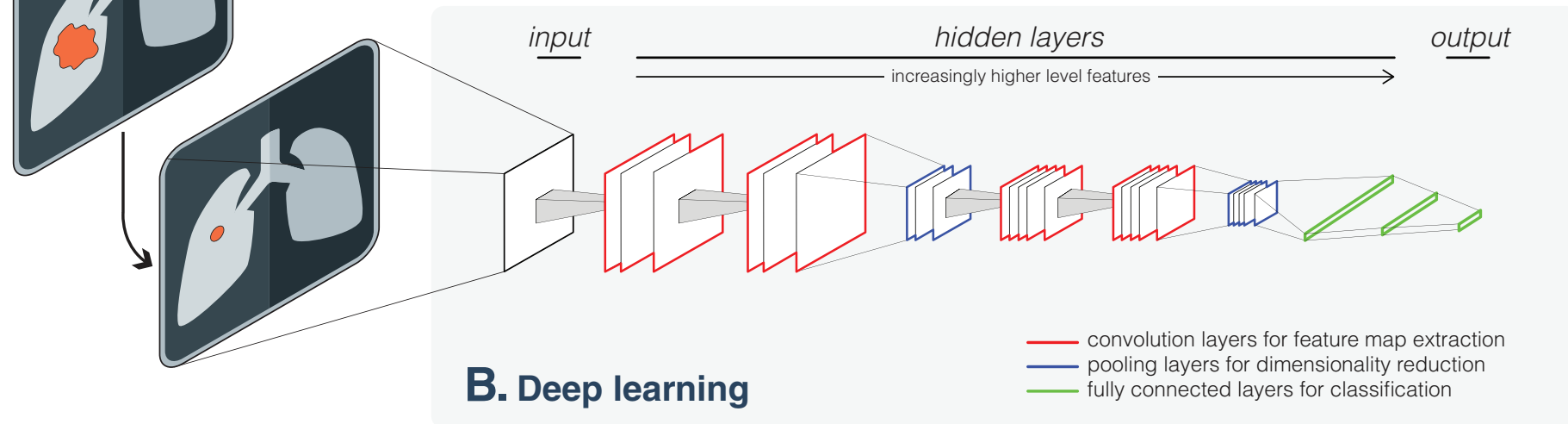
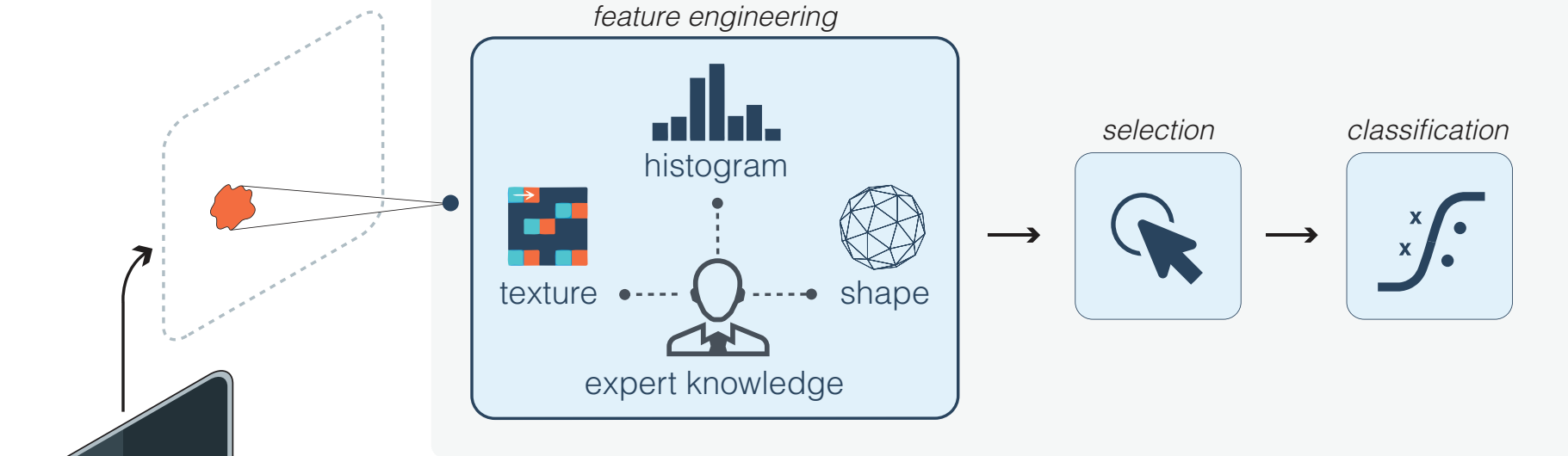


Artificial Intelligence Impact Areas within Clinical Imaging

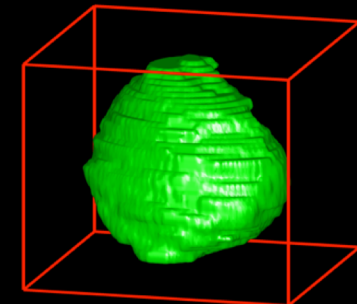
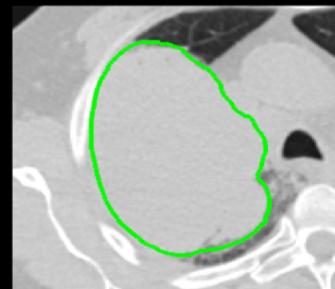
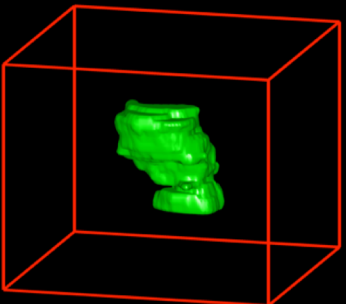
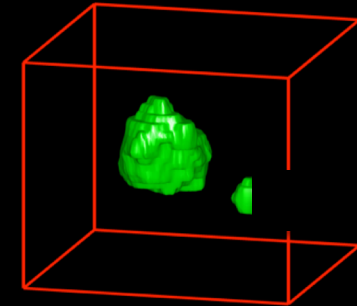
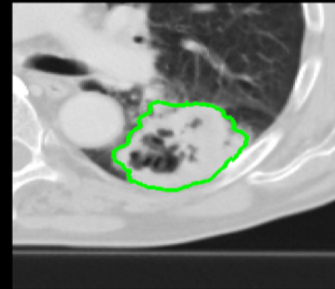
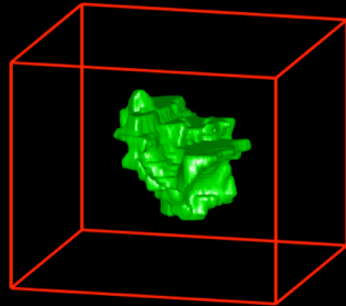
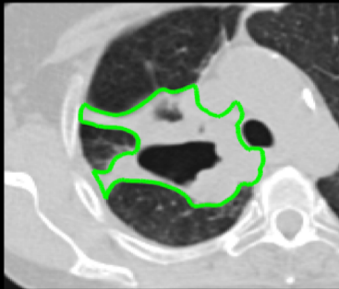
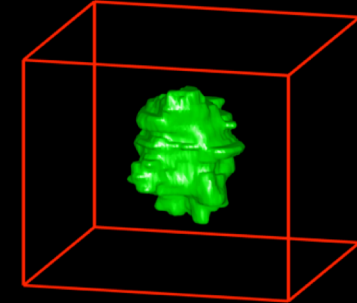
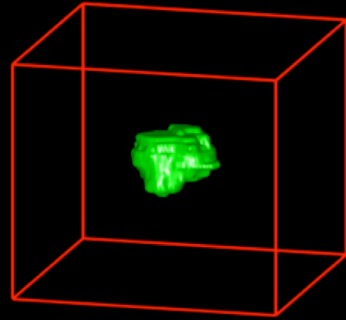


Artificial Intelligence (AI) Technologies in Medical Imaging

A. Predefined engineered features + traditional machine learning



Representative CT images of lung cancer



Tumors are different

Medical imaging can capture these phenotypic differences

Prognostic Radiomic biomarkers across cancer types

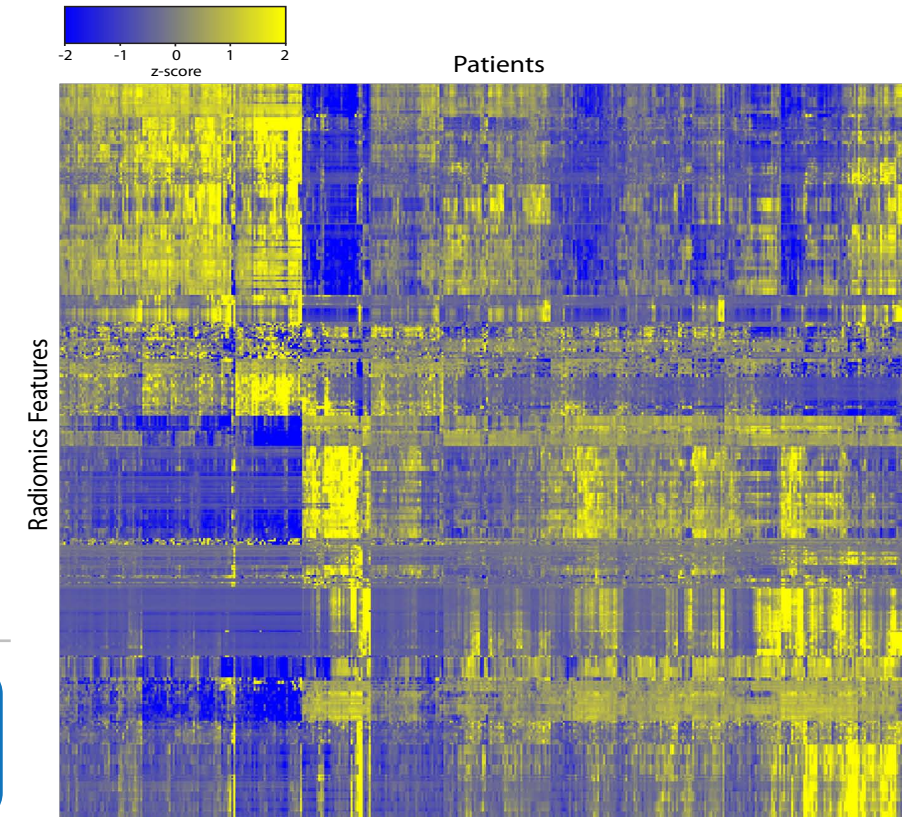
Main discoveries

- Radiomics analysis based on engineered algorithms on CT imaging of >1000 patients with Lung or H&N cancer
- Developed and validated a prognostic radiomics signature quantifying intra-tumor heterogeneity
- Radiomic signature outperformed volume and was complementary to TNM staging on all validation datasets
- Imaging-Genomics analysis showed strong correlations between radiomics and genomics data

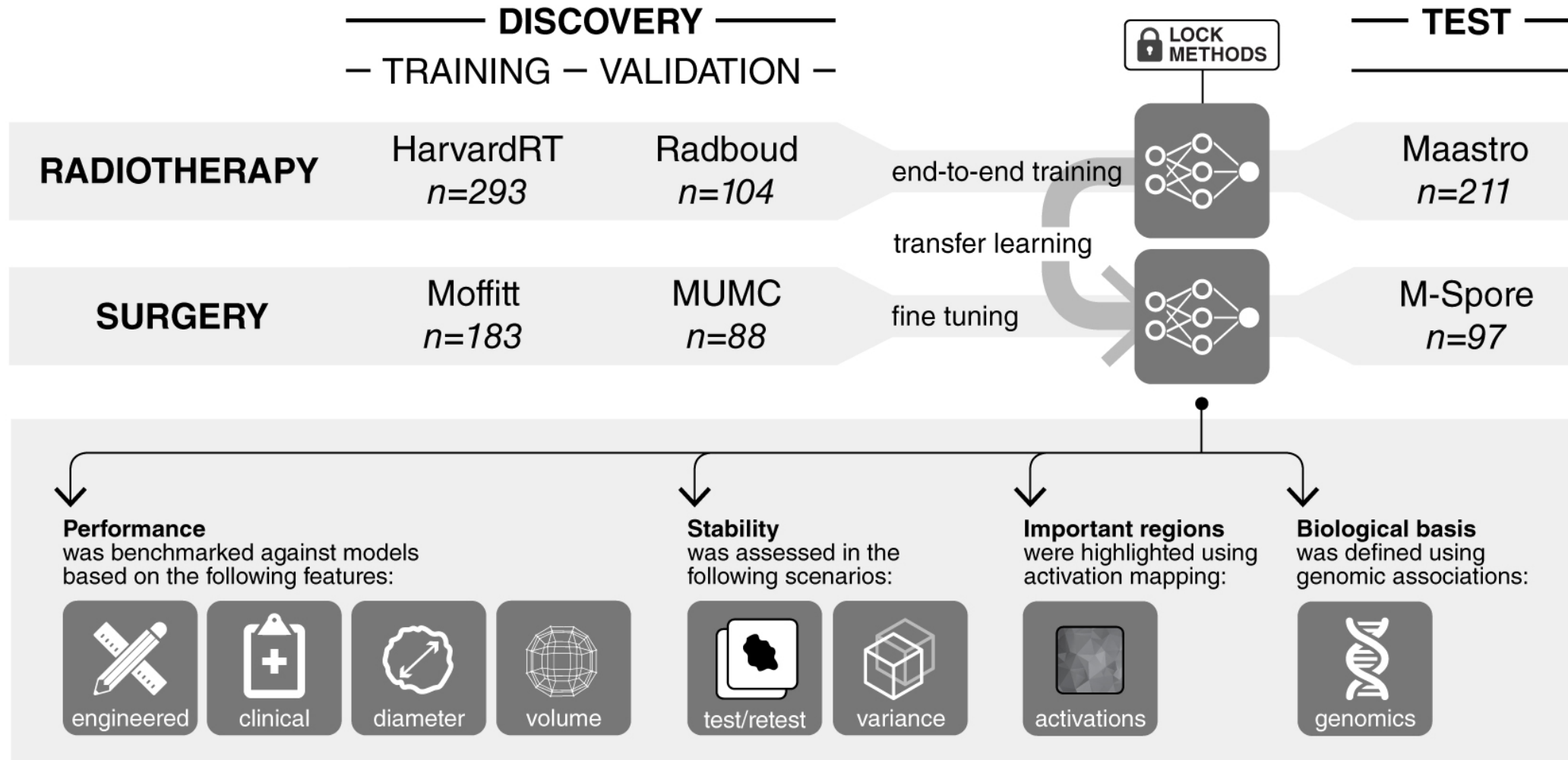
Discovery Cohorts



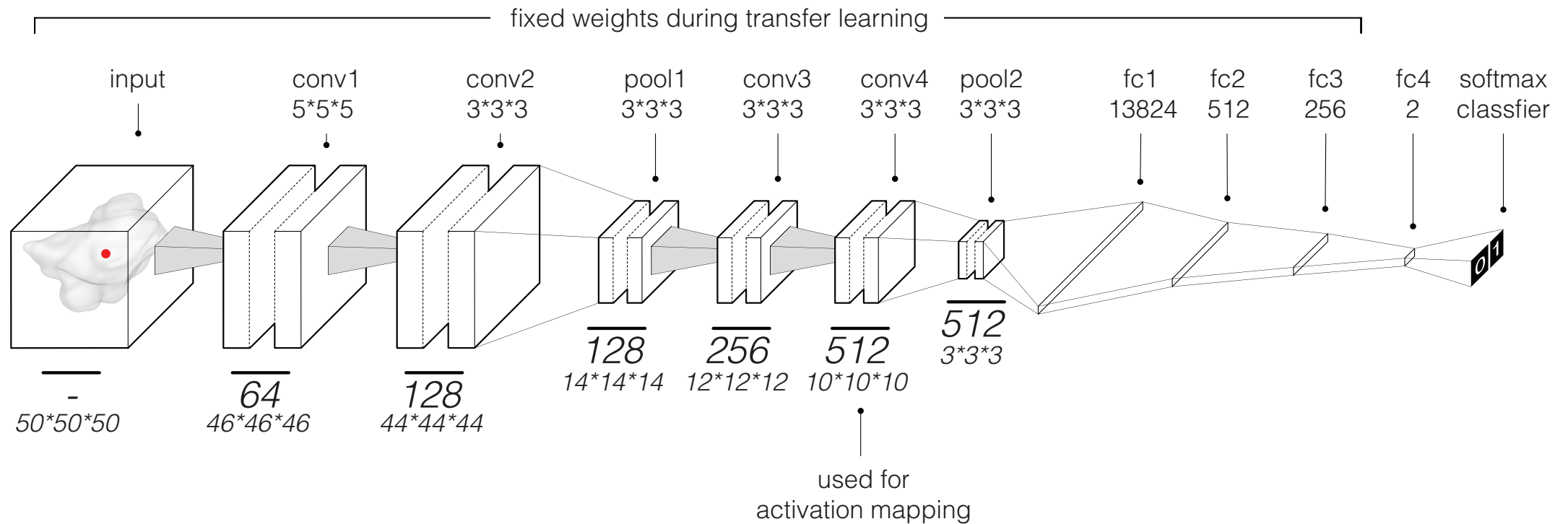
Validation Cohorts



Deep quantification of Lung Phenotypes using 3D CNNs



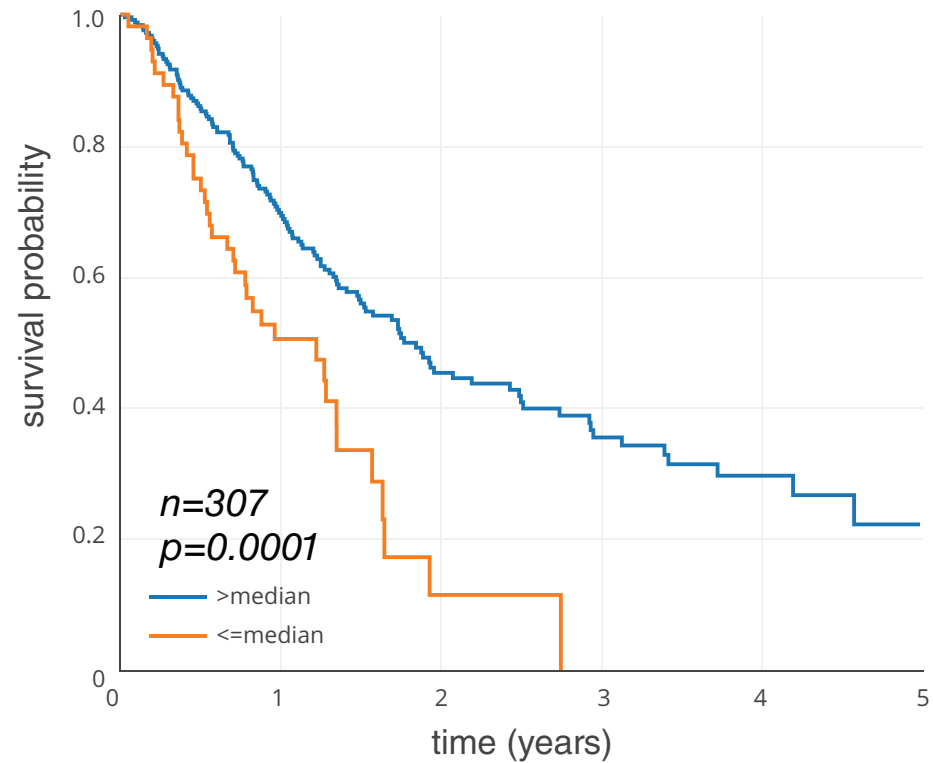
Deep quantification of Lung Phenotypes using 3D CNNs



Deep quantification of Lung Phenotypes using 3D CNNs

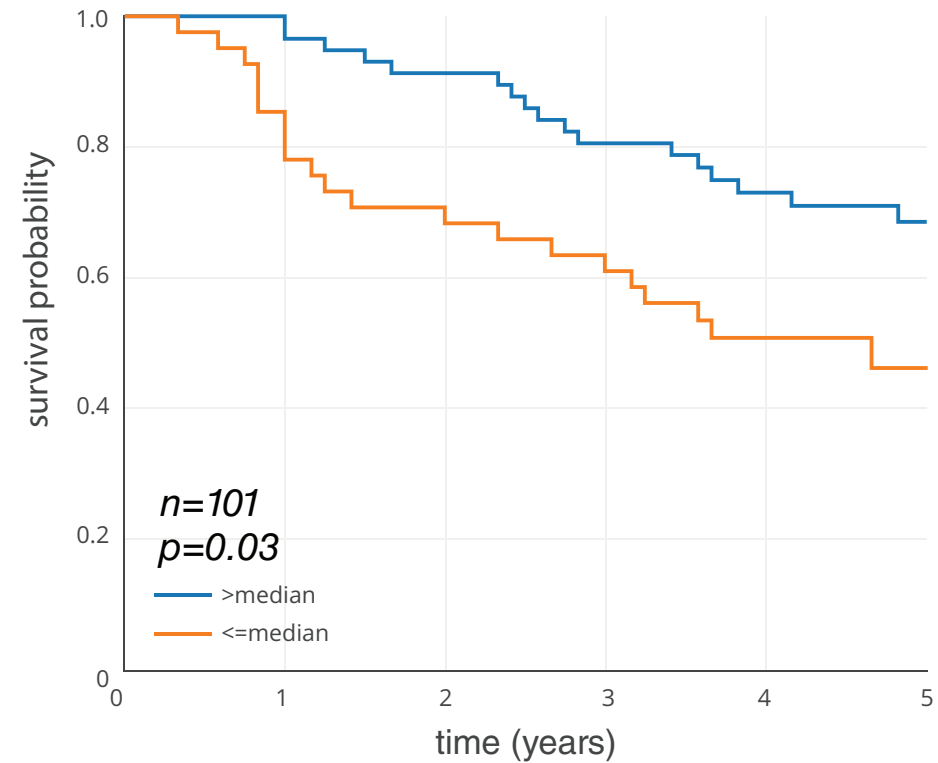
RADIOTHERAPY

B KM survival curve

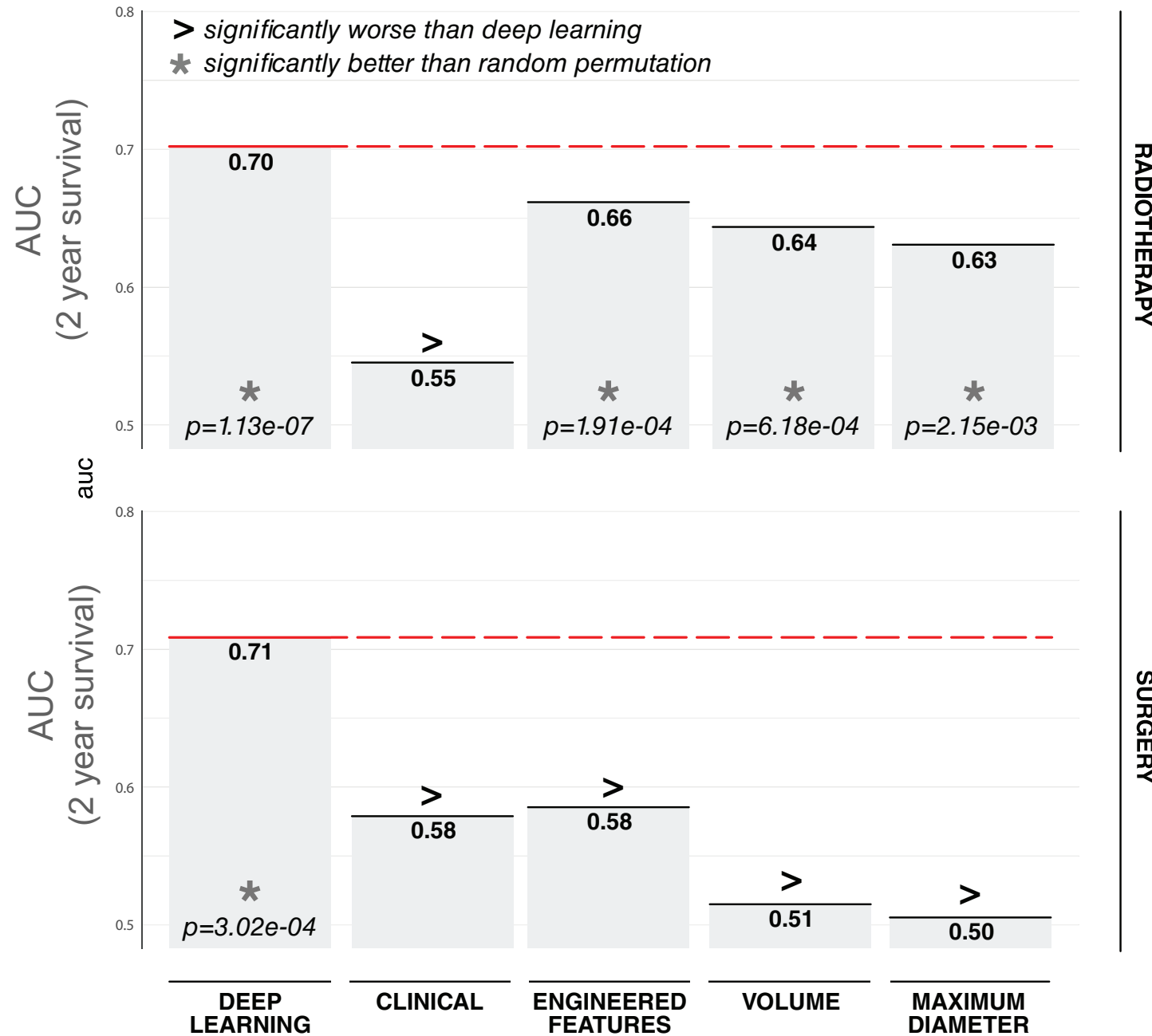


SURGERY

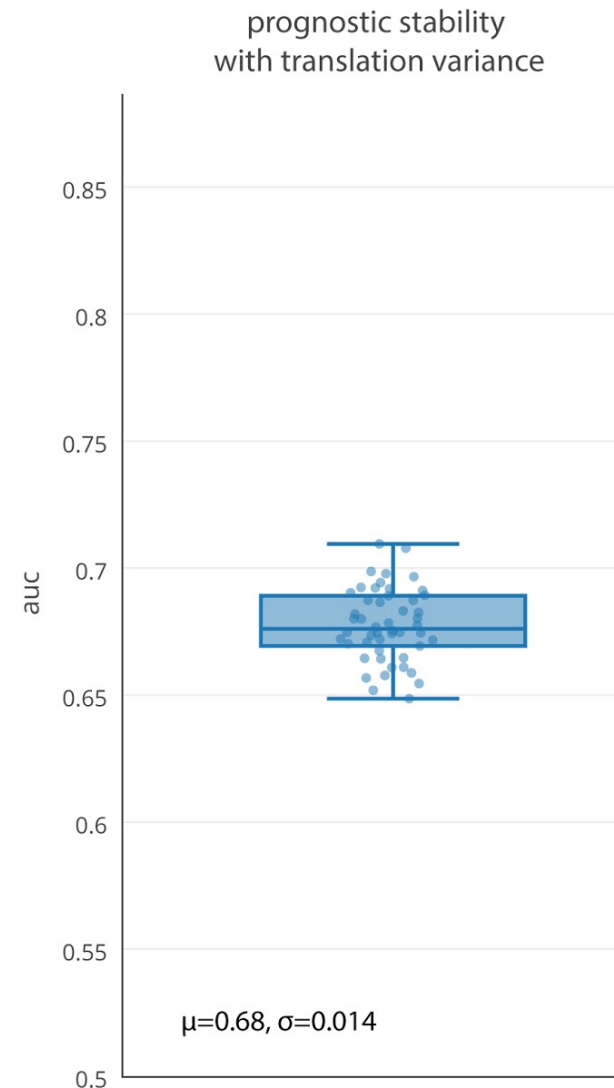
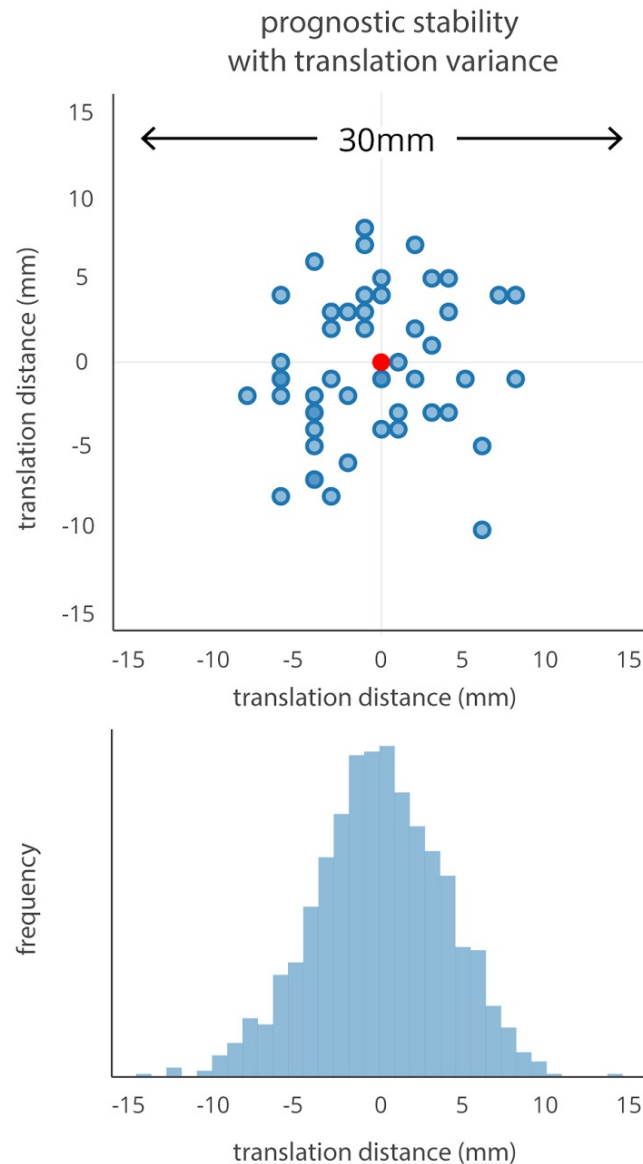
D KM survival curve



Comparison of prognostic data types and methods

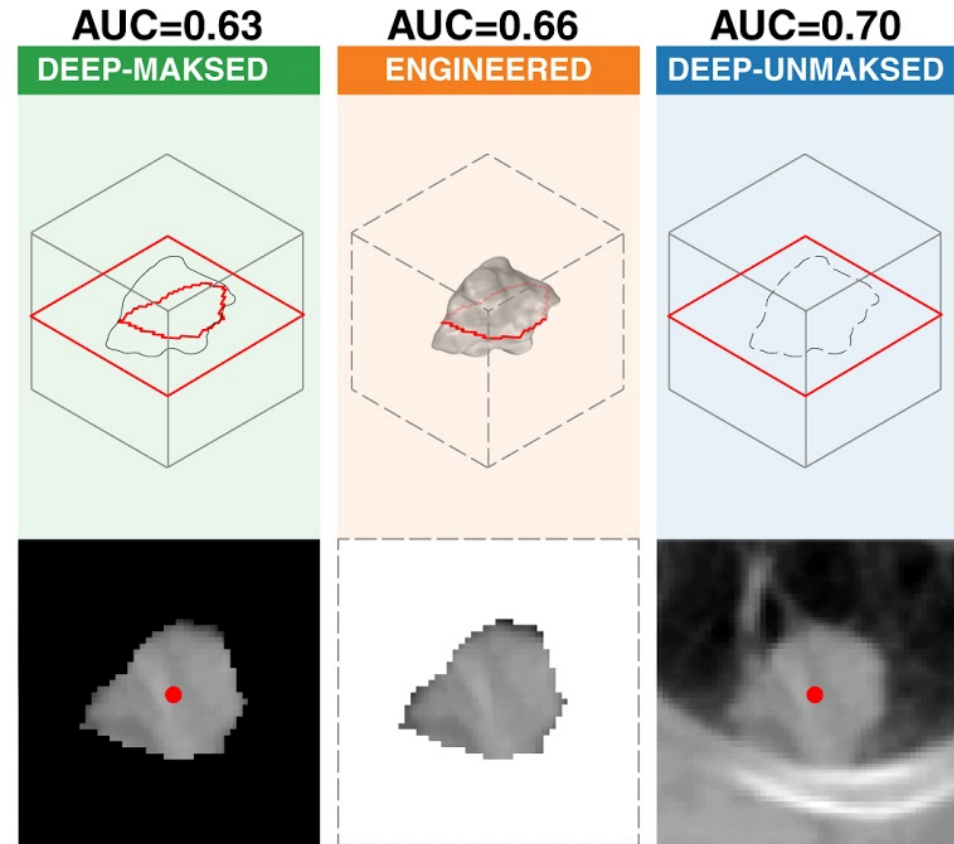
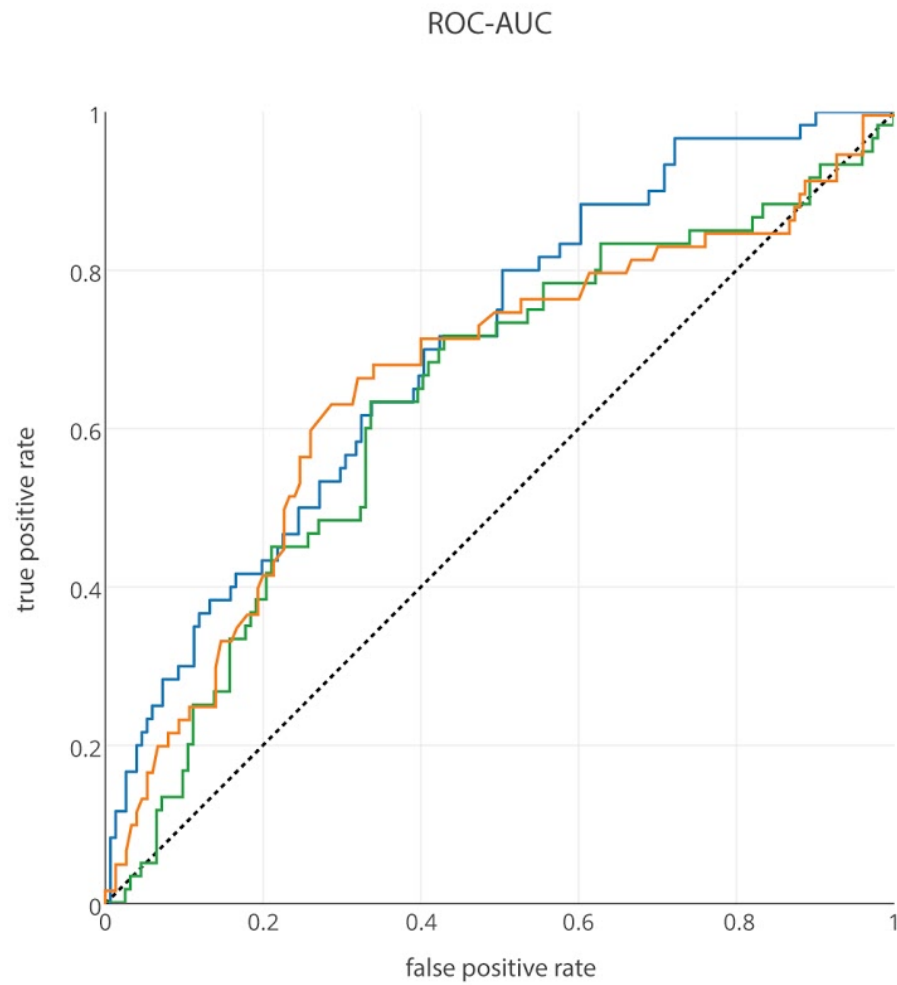


Stability of CNN for Prognostic Predictions



High stability of predictions: intra-class correlation coefficient (ICC) = 0.91

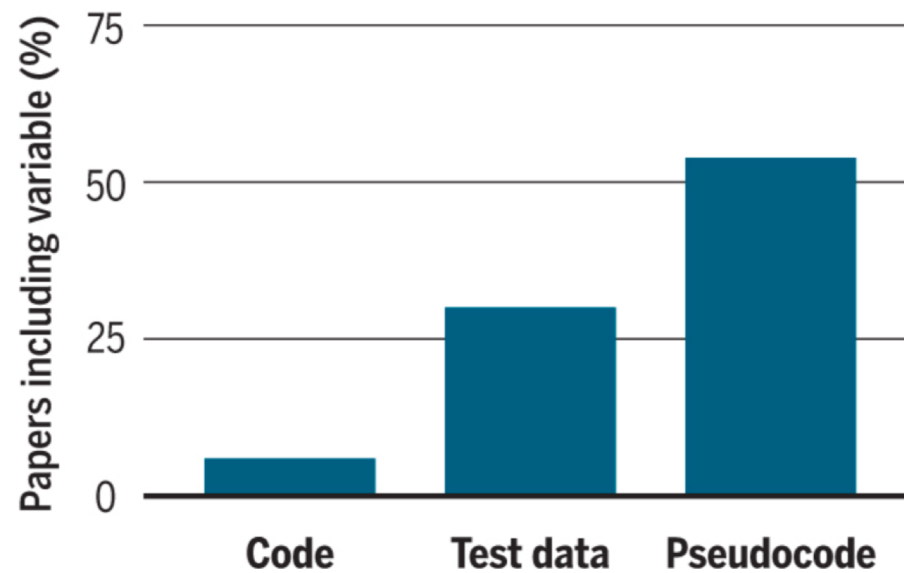
Spatial Information for CNNs predictions



Artificial Intelligence Faces Reproducibility Crisis

Code break

In a survey of 400 artificial intelligence papers presented at major conferences, just 6% included code for the papers' algorithms. Some 30% included test data, whereas 54% included pseudocode, a limited summary of an algorithm.



Radiomics Platforms

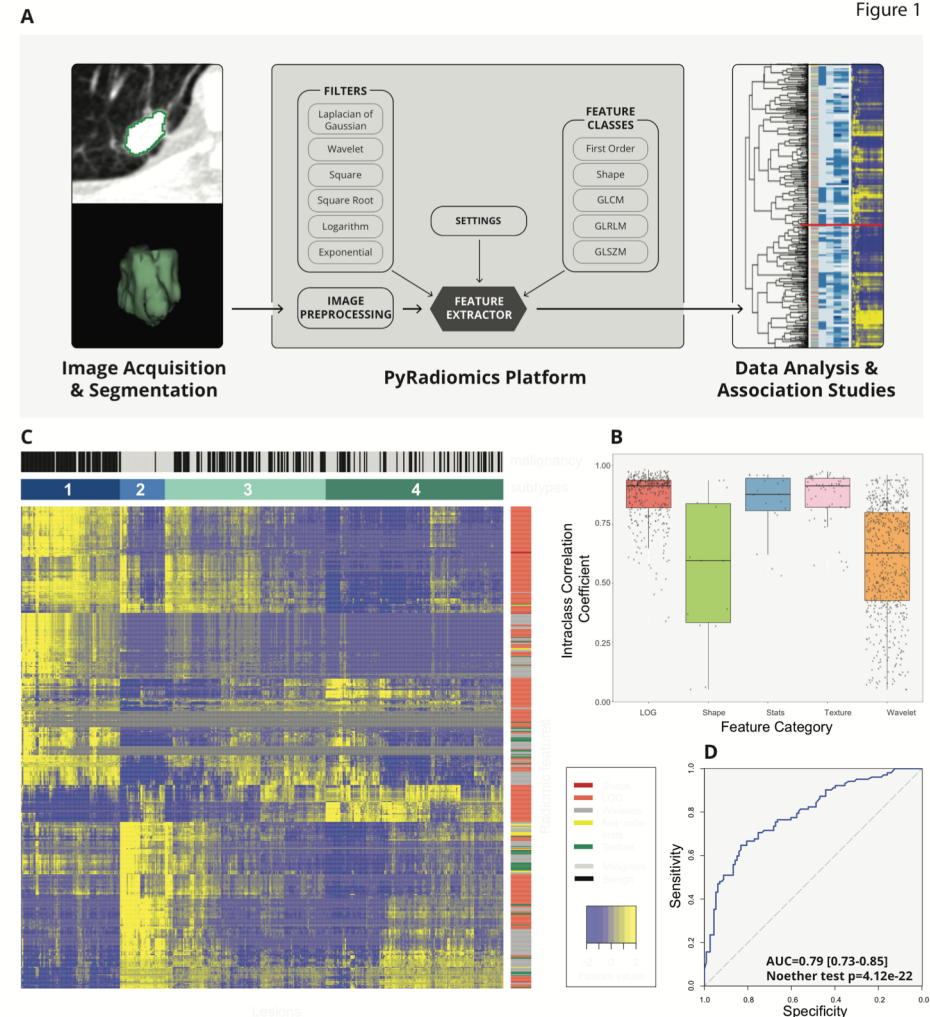
- Radiomics platforms for disease characterization, Tx response, correlation with genomic biomarkers
- Evaluation status: QIN single and multi-site evaluations underway
- Availability status: publicly available
- Supported by NCI QIN and ITCR programs



Quantitative Radiographic Phenotyping

<https://radiomics.io>

Figure 1



Mathematical Oncology

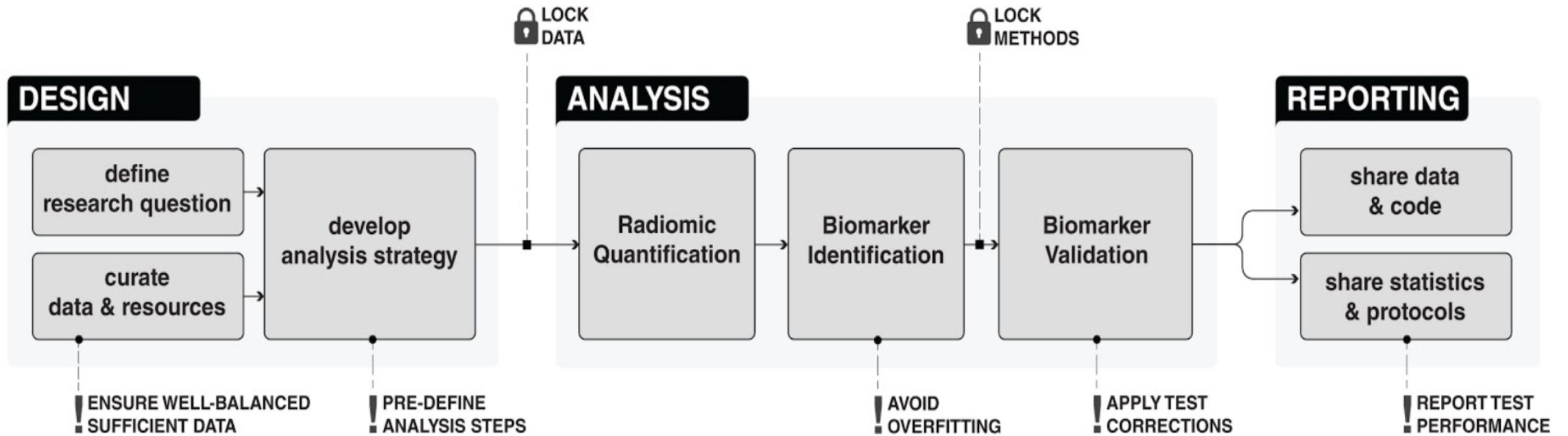
Cancer Research

Computational Radiomics System to Decode the Radiographic Phenotype

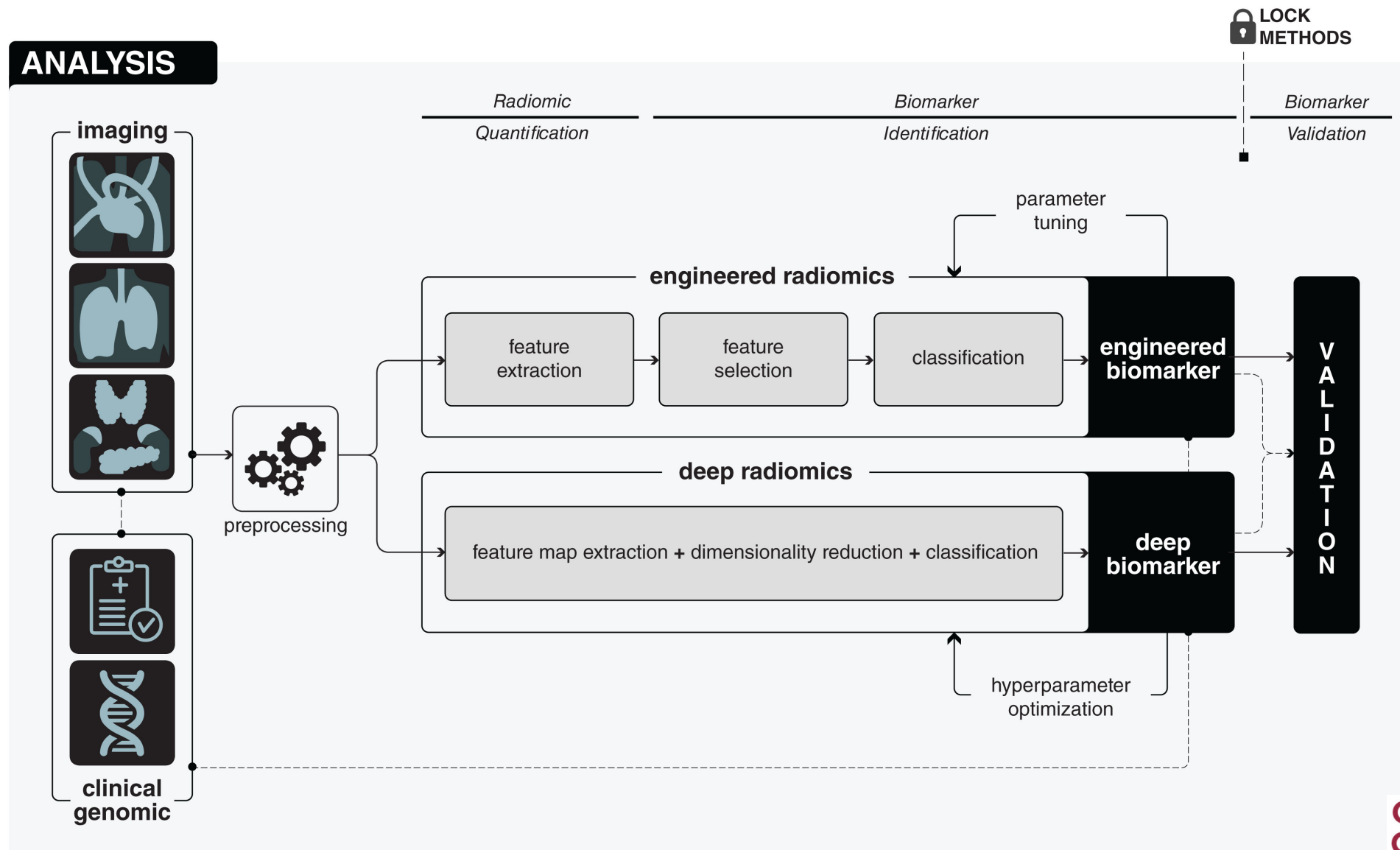
Joost J.M. van Griethuysen^{1,2,3}, Andriy Fedorov⁴, Chintan Parmar¹, Ahmed Hosny¹, Nicole Aucoin⁴, Vivek Narayan¹, Regina G.H. Beets-Tan^{2,3}, Jean-Christophe Fillion-Robin⁵, Steve Pieper⁶, and Hugo J.W.L. Aerts^{1,4}



Data analysis stages in medical imaging



Data analysis stages in medical imaging



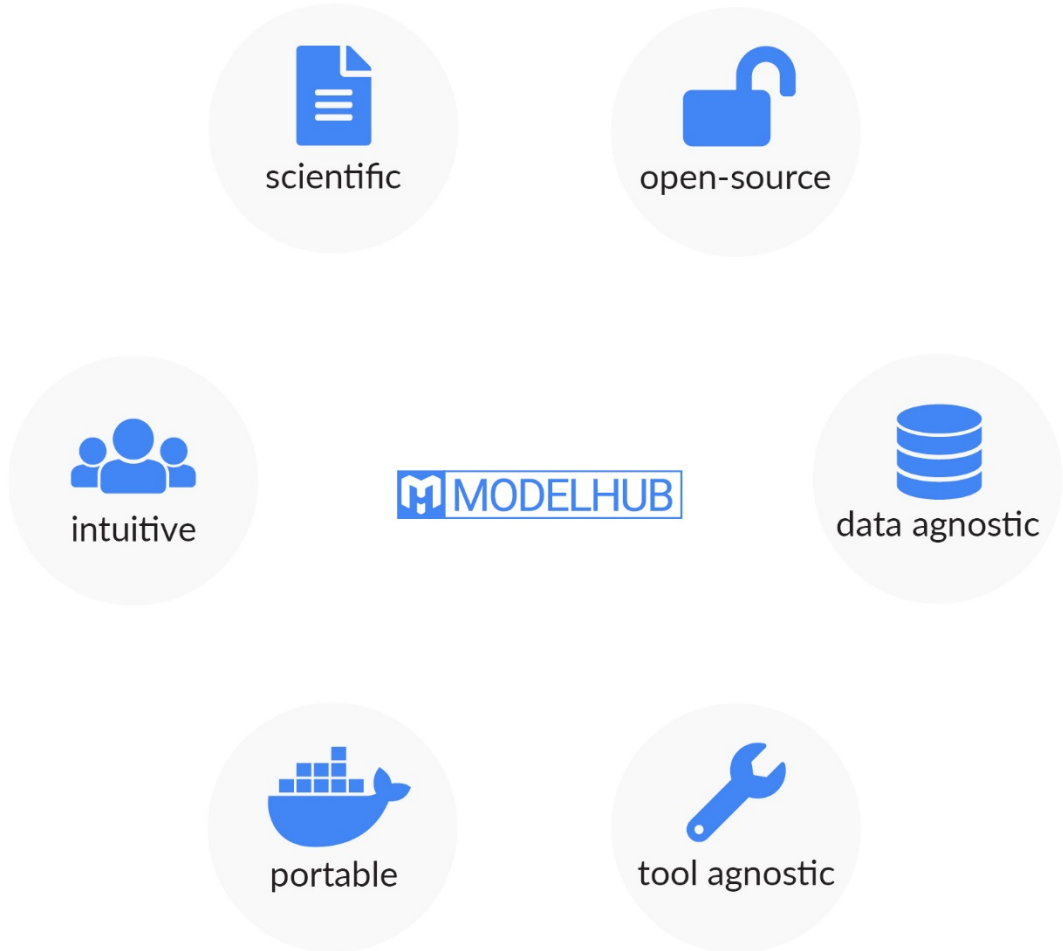
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Components



scientific

open-source

data agnostic

tool agnostic

portable

intuitive

MODELHUB

How it Works

