Machine Learning-powered Radiation Dose Reconstruction for Pediatric Cancer Survivors

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Problem setting

- Radiotherapy important in cancer treatment

  \+ Improves survival rates

  \- Adverse effects
  (damage to healthy tissue)

Image from www.europeanpharmaceuticalreview.com

Problem setting

- Treatment planning:
  Trade-off delivery enough tumor irradiation
  spare nearby organs-at-risk

E.g., spare salivary glands

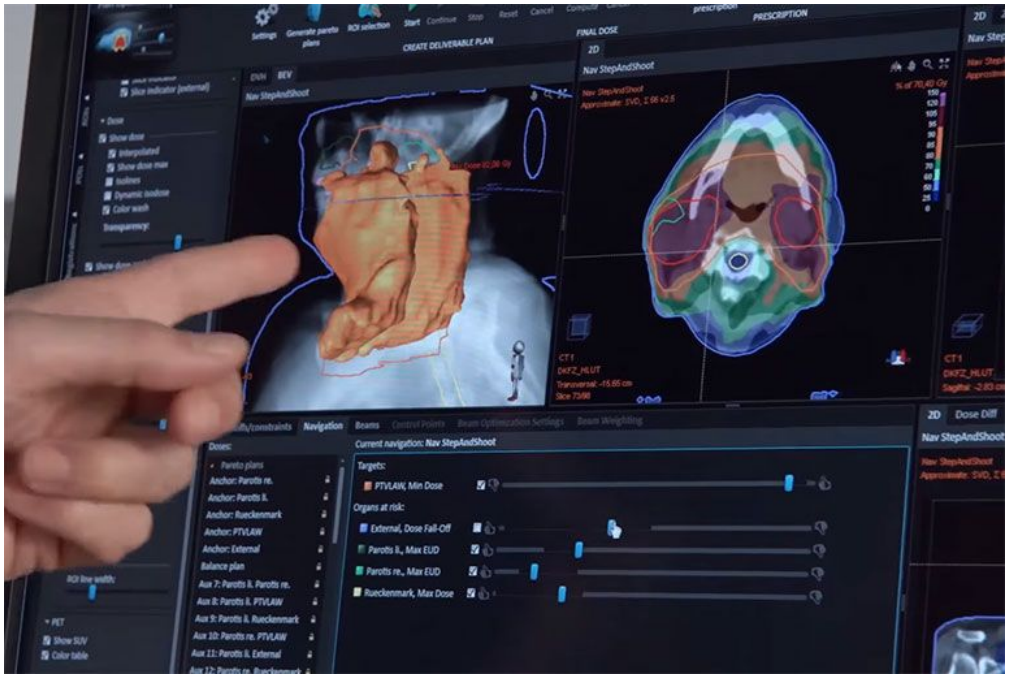


Image from www.medgadget.com

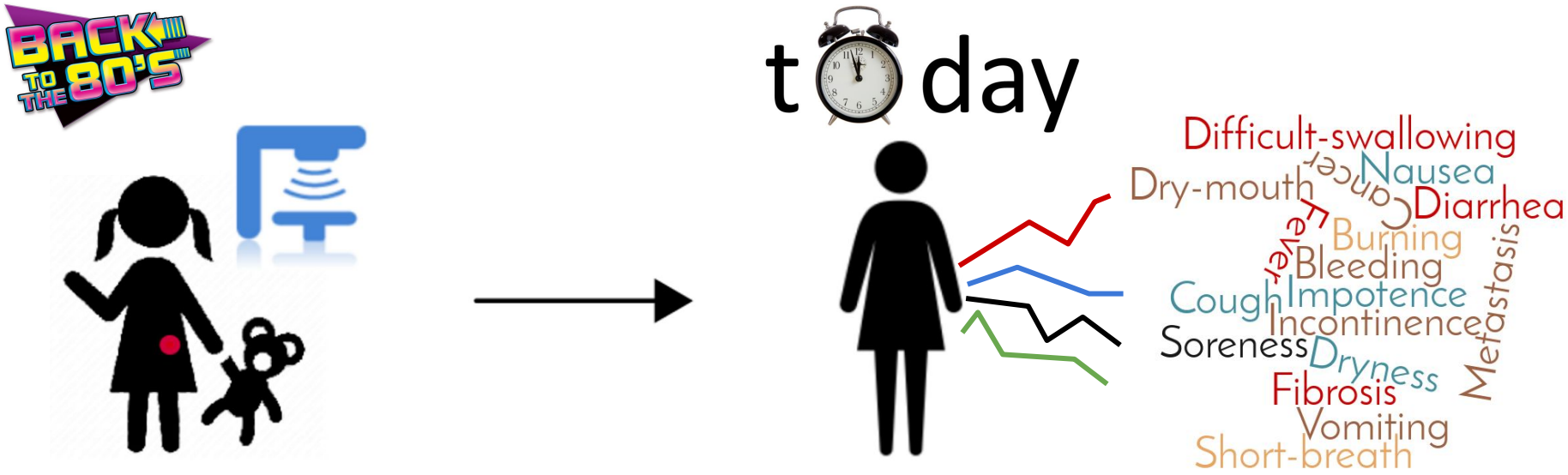
Our problem

- Provide doctors with info on
  radiation dose <-> adverse effects relationship

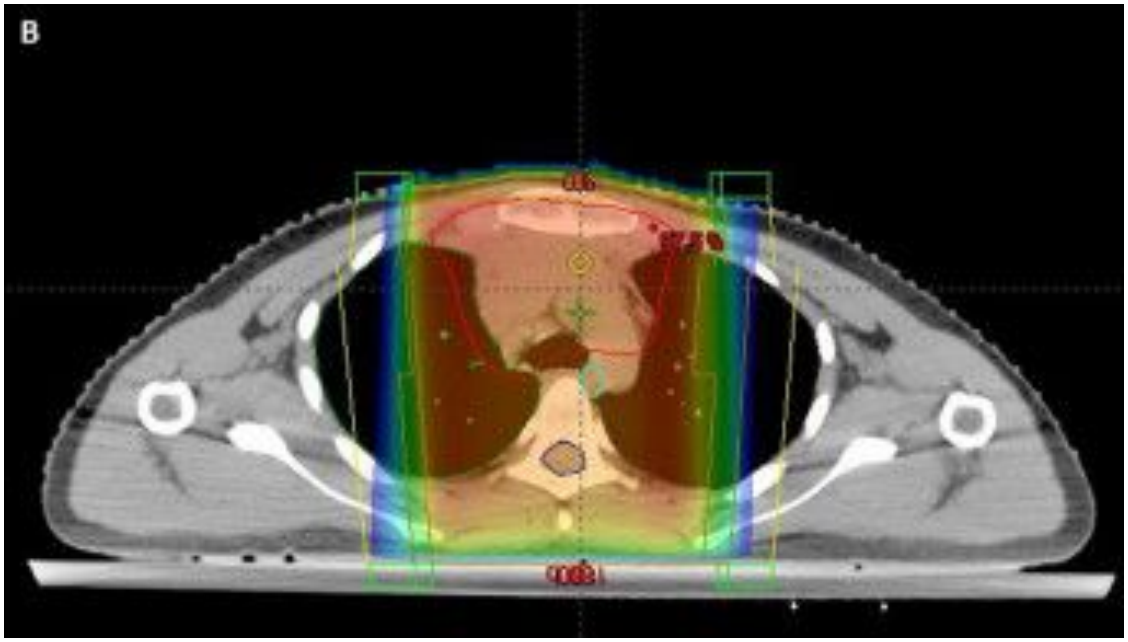
- To better understand trade-off & improve treatments

Our problem

- Provide doctors with info on
  radiation dose <-> adverse effects relationship
- To better understand trade-off & improve treatments
- We consider <u>late</u> adverse effects: happen <u>decades</u> after treatment

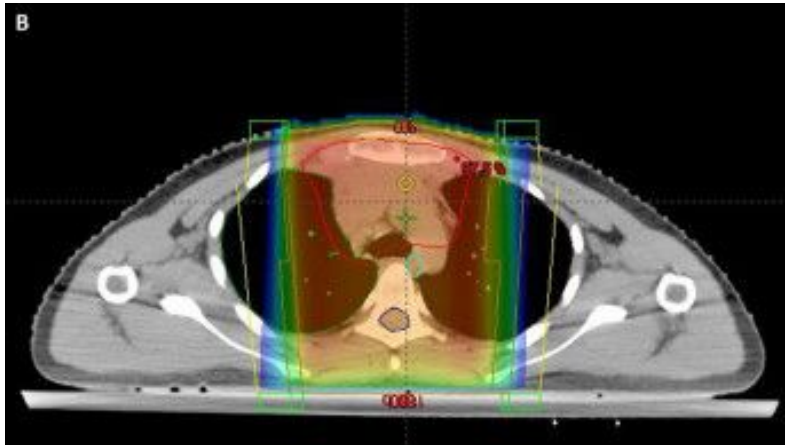


What we need: 3D dose distribution



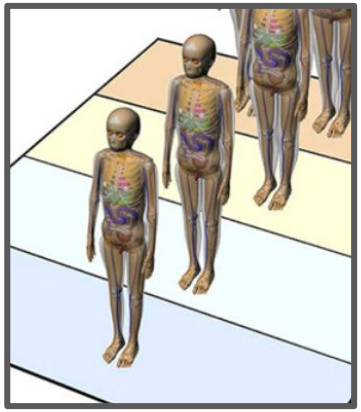
What we have: limited information from past

Aim

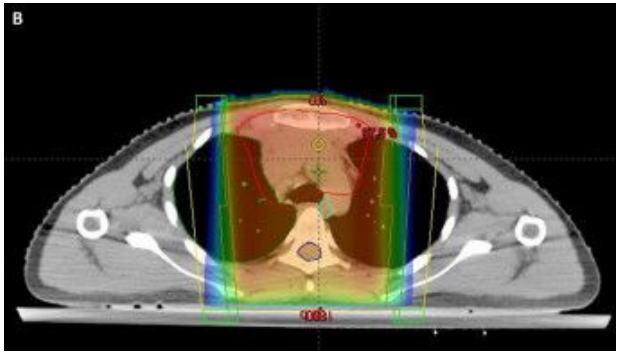


Dose reconstruction

Past features



Select representative PHANTOM



Get dose estimation by treatment simulation on phantom

What we are doing

- Two approaches, using Machine Learning

Approach 1:
Automatic ML-powered phantom construction

- Machine-learn models linking past features (2D) w/ 3D anatomical metrics
- Use 3D metrics to generate phantom

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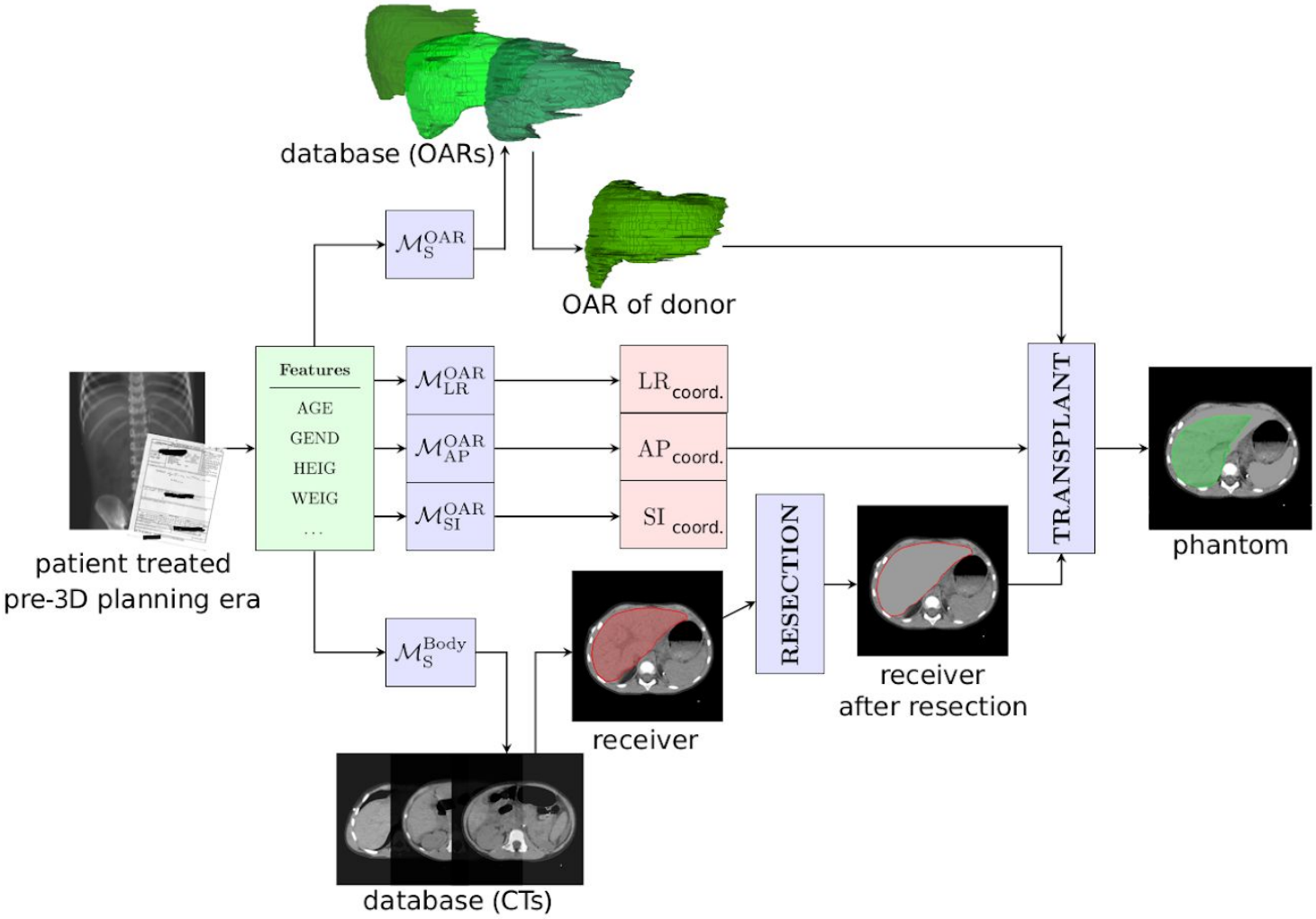
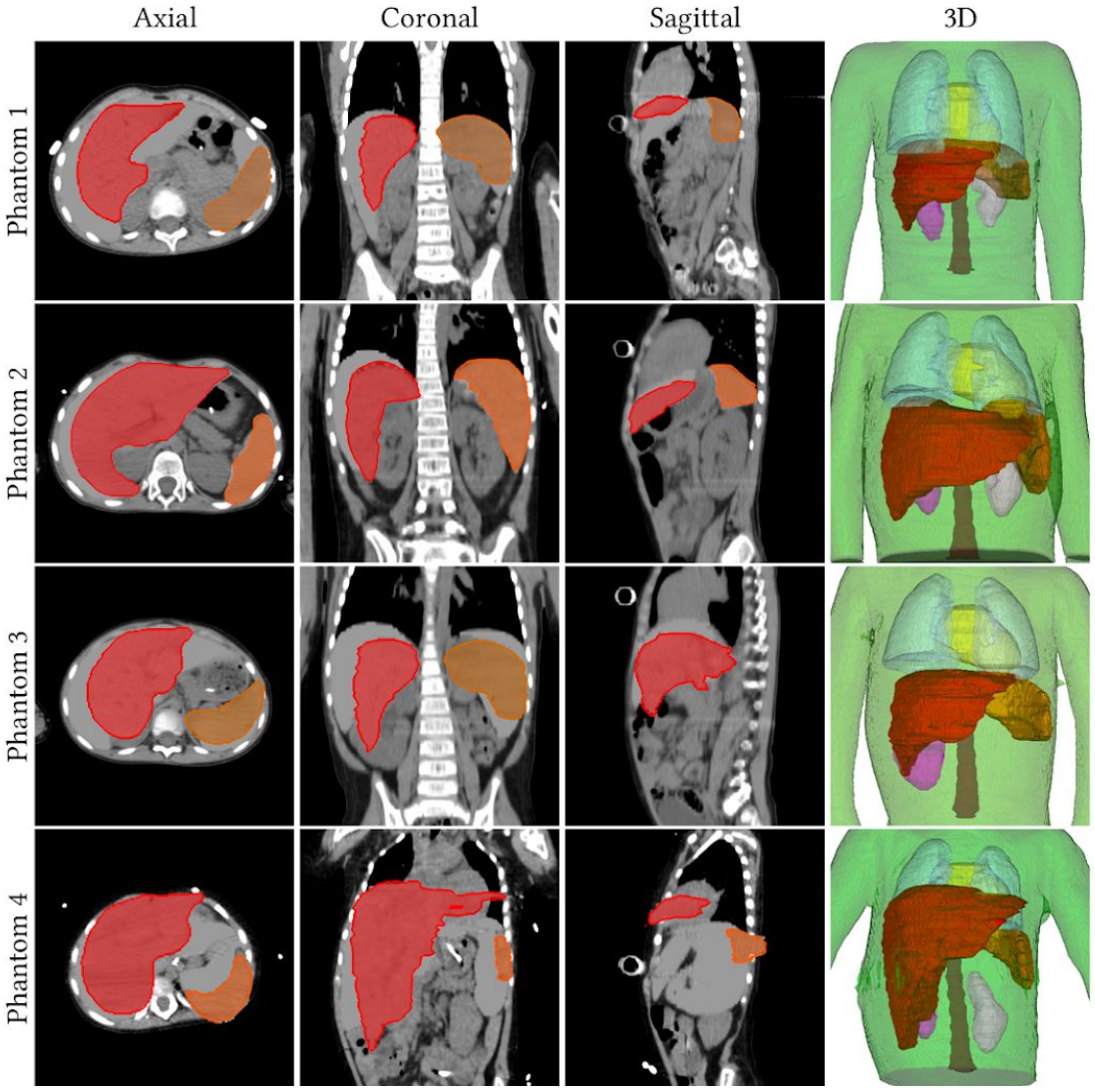
Automatic ML-powered phantom construction

- Machine-learn models linking past features (2D) w/ 3D anatomical metrics
- Use 3D metrics to generate phantom
- *How to have examples of 2D-to-3D relationship?*
    a. Take 3D patient imaging (CT scan)
    b. Transform into 2D (historical-like radiograph), extract past features
- Train associations between 2D features and 3D metrics

Approach 1:
Automatic ML-powered phantom construction



Approach 1:
Automatic ML-powered phantom construction



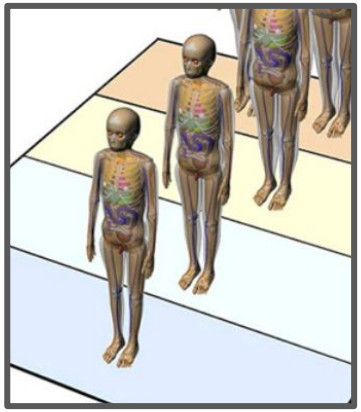
Approach 2

- Approach 2) Machine-learn a link between past features (2D) and ...

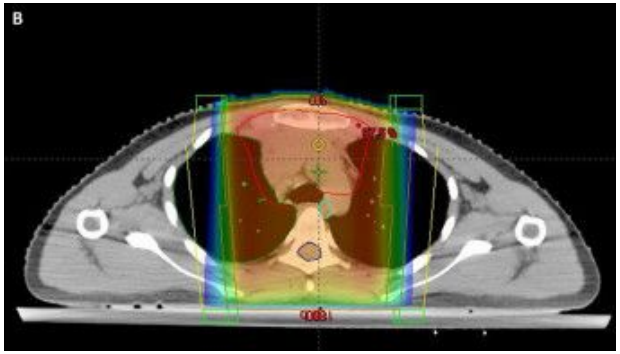
Approach 2: look back at dose reconstruction

- Essentially, this:

Past features



Select representative PHANTOM



Get dose by treatment simulation on phantom

Approach 2: look back at dose reconstruction

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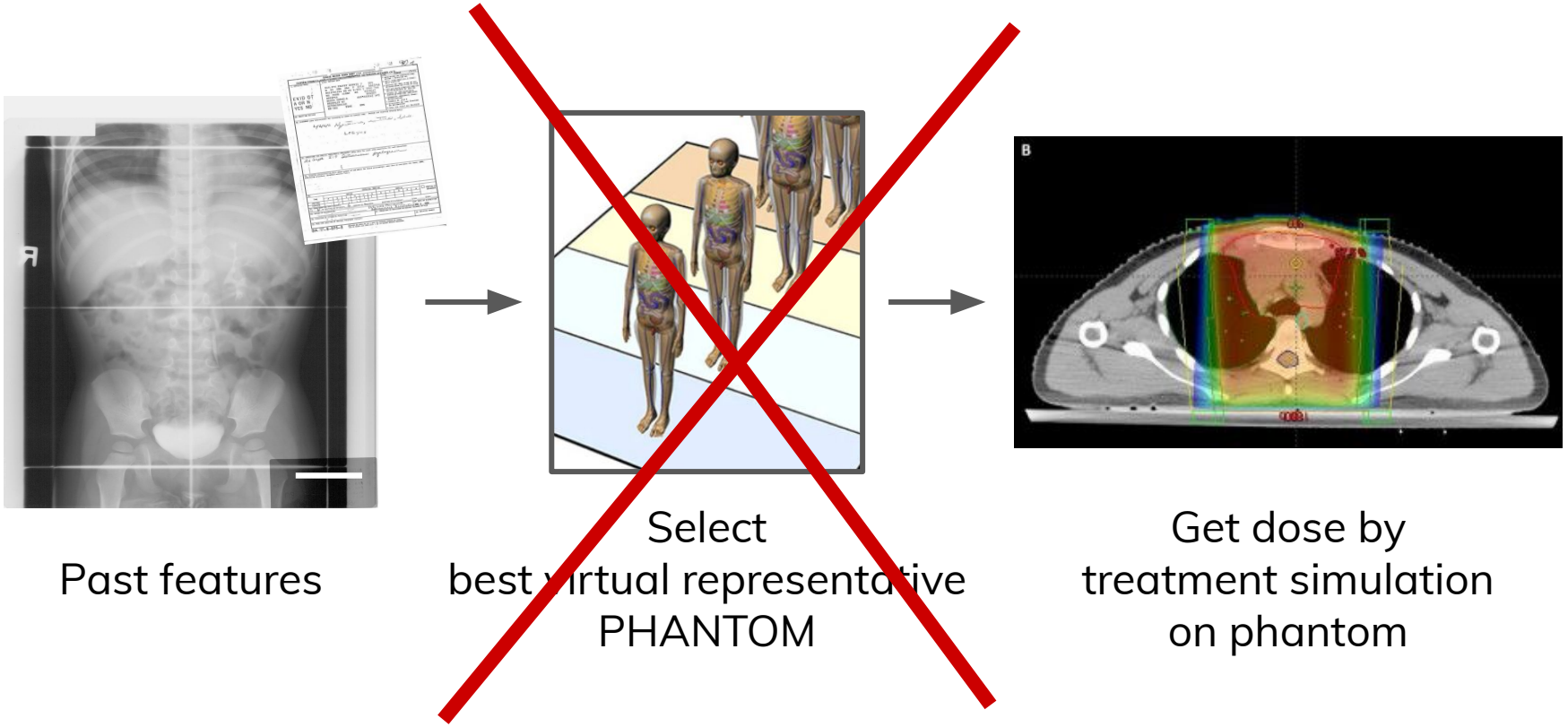


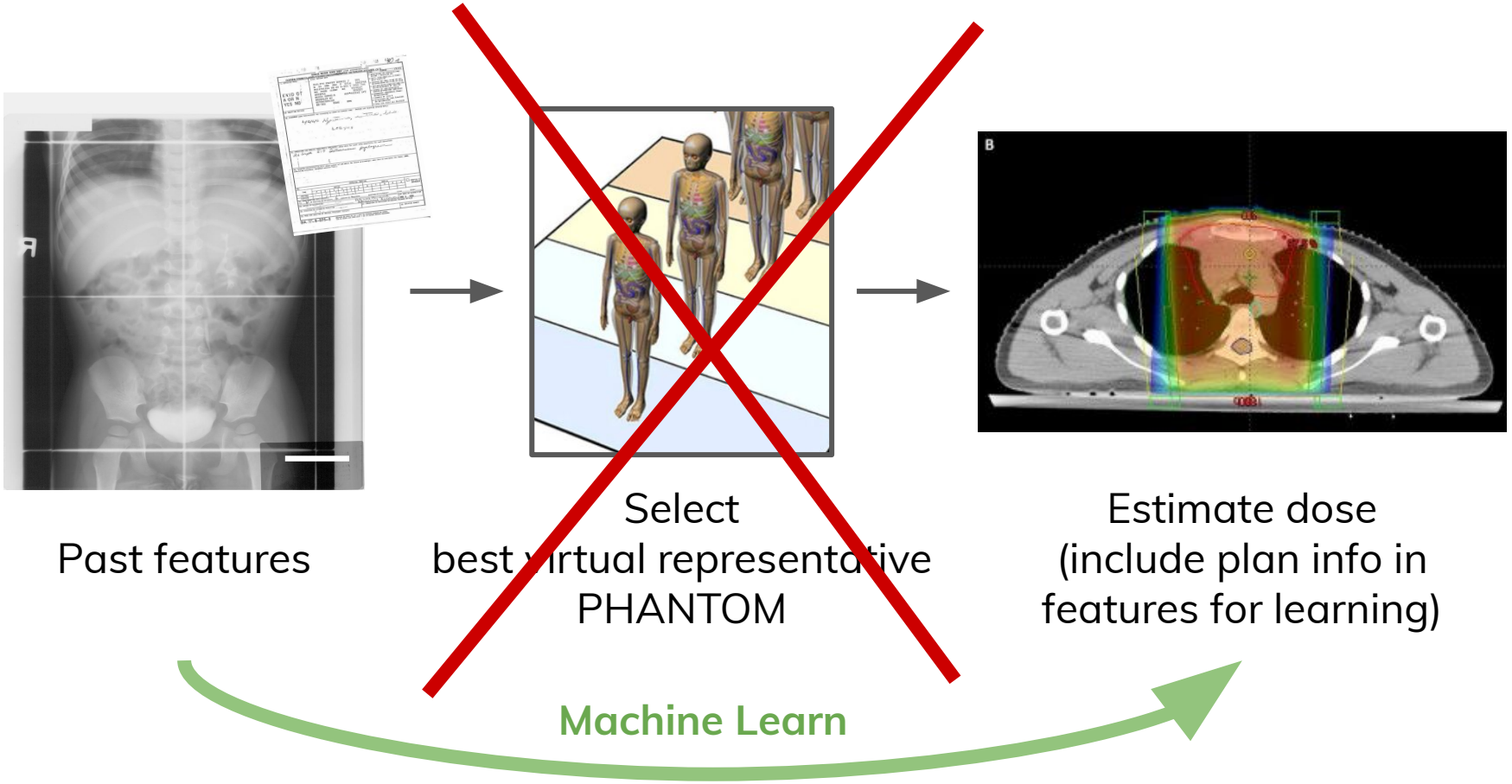
Past features

Select
best virtual representative
PHANTOM

Get dose by
treatment simulation
on phantom

Approach 2: look back at dose reconstruction

- Essentially, this:



Ongoing work

- Validation of our approaches: is the dose reconstruction acceptable?
- Comparison with 2 institutes in US that perform phantom-based dose reconstruction

Thank you!