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)
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 late adverse effects: happen decades 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
Approach 1:
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?
  - Take 3D patient imaging (CT scan)
  - 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

- Essentially, this:

  
  ![Diagram showing the process of selecting the best virtual representative phantom and obtaining dose by treatment simulation on the phantom.]

  - Past features
  - Select best virtual representative PHANTOM
  - Get dose by treatment simulation on phantom
Approach 2: look back at dose reconstruction

- Essentially, this:

  - Past features
  - Select best virtual representative PHANTOM
  - Machine Learn
  - Estimate dose (include plan info in features for learning)
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!