Data Driven Strategy for Optimized IMRT planning for Head and Neck Radiation Oncology Therapy

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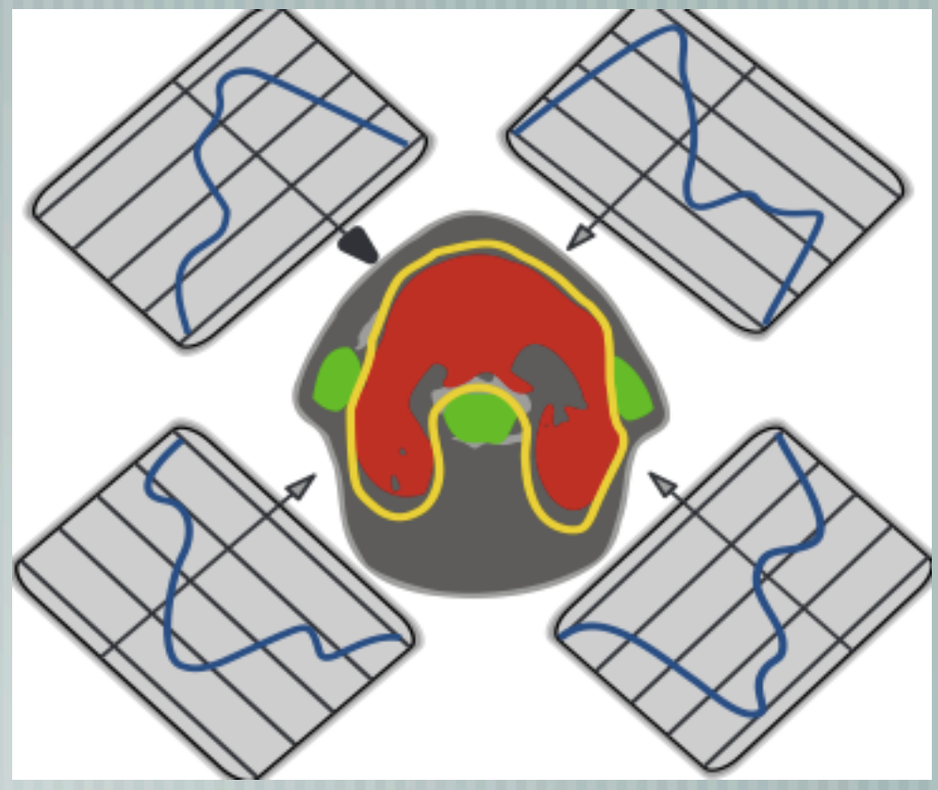
Contents

Background (1)

Intensity Modulated Radiation Therapy(IMRT)

- The intensity of each beam can be modulated to form a unique geometry that delivers a planned intensity of dose for Planned Target Volume(PTV) of target organ.

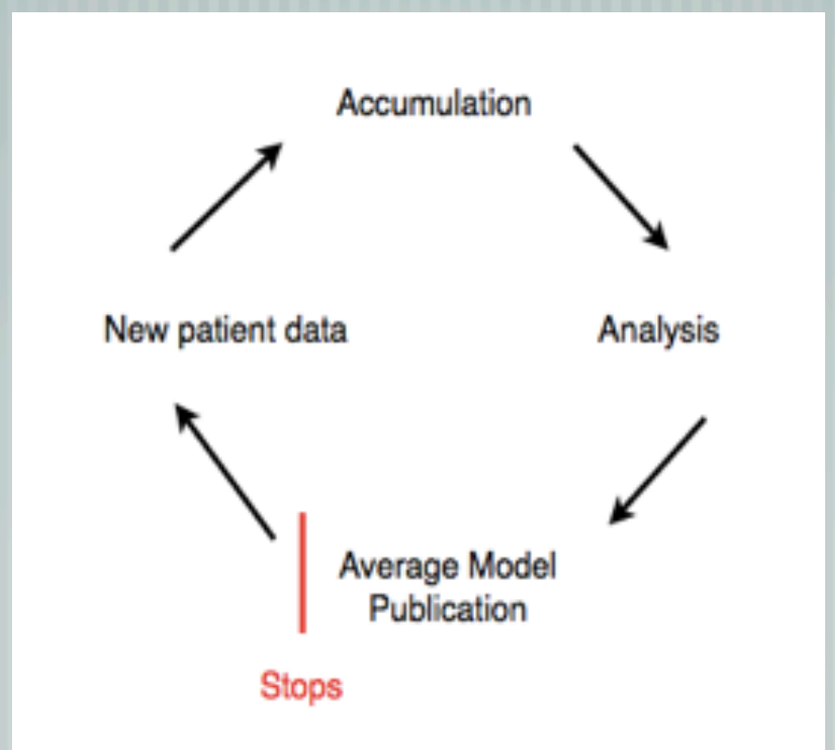


- Even though carefully planned, adjacent organs that may have critical functions may be radiated, we call such organs Organs At Risk (OAR)

- The goal of IMRT therapy is to while delivering planned intensity for PTV, spare as much volume of OAR as possible

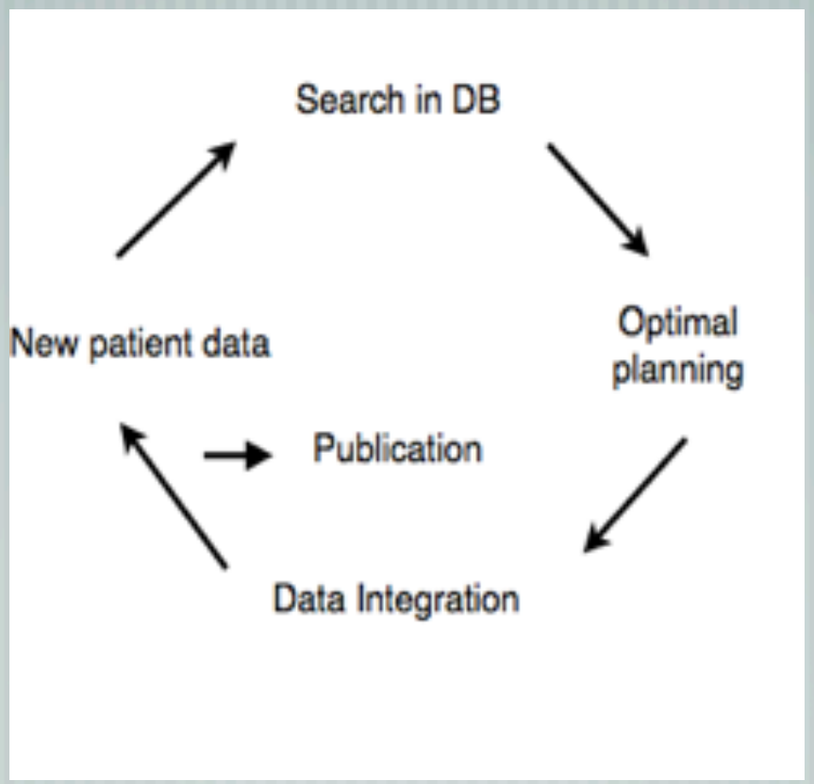
Background (2)

- Former planning method
  - Manually and based on personal experience
  - Slow, neglect previous patient information



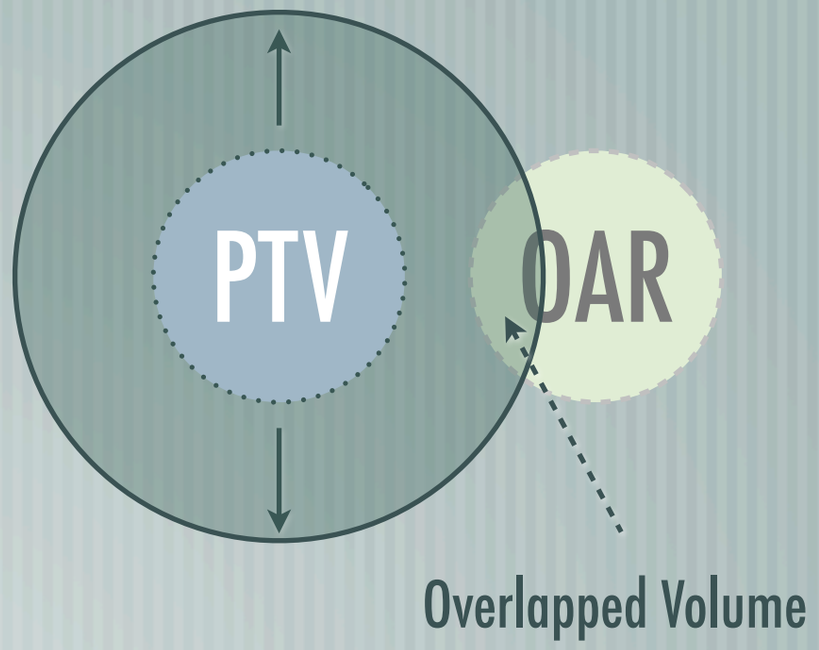
Background (3)

- A new planning method
  - Make full use of previous patient data
  - Dynamic cycling of knowledge maintenance



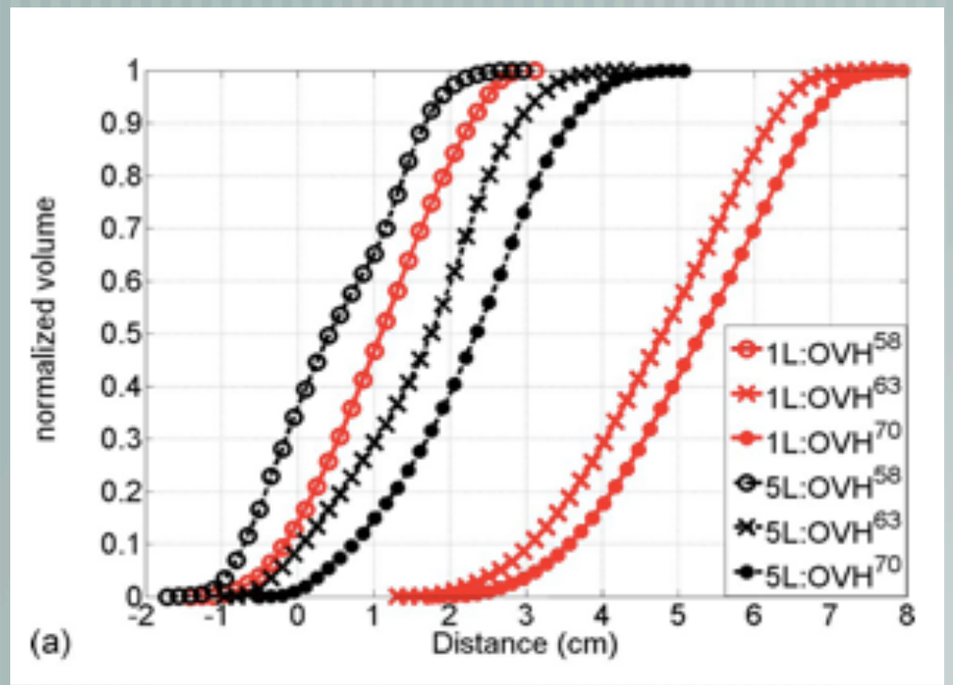
Background (4)

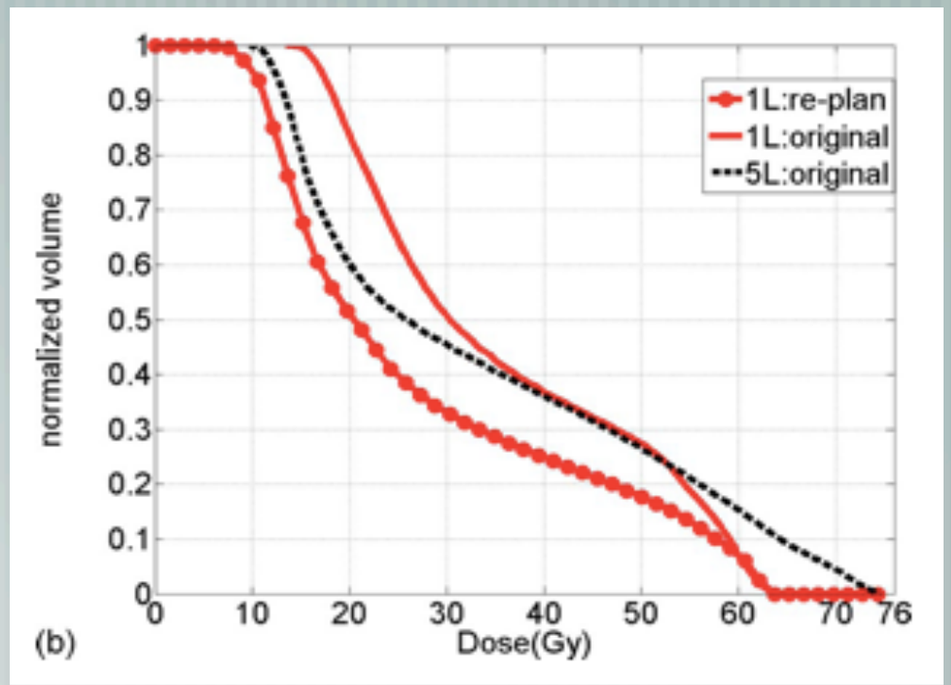
- New parameter introduced
  - Overlap Volume Histogram (OVH)
    - Represents the distance from OAR to PTV/contains information of the shape of OAR
    - Can be drawn from current patients



Background (5)

From OVH to Dose-Volume Histogram (DVH)





OVH → DVH

Courtesy of Dr. Todd McNutt and Wu Binbin

Background (6)

- If the OVH indicates the distance(or distance/shape related) between OAR and PTV in the current patient is larger than previous patients;

- But the dose the current patient is receiving is higher than some of the previous patients;

- Then there should exist a plan that at least let the dose of current patient equals(or even less than) the selected previous patients.

Background (7)

Workflow

1. Current Patient OVH

2. Search database for all previous patients that is harder to plan(left side of OVH)

3. Map to the DVH of current patient and previous patients

4. If DVH indicates a previous patient had general lower dose received than the current patient

5. Get the plan of that patient

6. Optimized planning (search result + manual trimming)

7. Integrate current patient information into database

8. Next planning

Background (8)

- Advantages of data driven planning
  - Fast
  - Optimization by making full use of previous patient information(OVH and DVH)
  - Dynamic growth of data and knowledge (the database is becoming more and more intelligent and affecting the treatment plan of the next patient)

Goal

- Build a package based on python for head and neck radiation therapy planning (pinnacle 3 script generating application)

Technical Approach

Matlab package for head and neck planning

Python package for thoracic radiation therapy etc.

SQL query for faster database search and comparison

Integration

Modification for Head and Neck planning

Integration

Python package that was based on an optimized searching strategy(in SQL , already partially coded) and works for head and neck planning.

Timeline For This Project

		Febuary		March				April (1)		April (2)		May	
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Milestone 1	1. Read through materials												
	2. Familiar with existing python code												
	3. Familiar with existing matlab code												
	4. Familiar with pinnacle 3 script												
	Validation for milestone 1: Documentation of the structure of existing modules.												
Milestone 2 (*Minimum Deliverable*)	1. Modification of python code												
	2. Translation of Matlab code												
	3. Integration, test run and documentation												
	Validation for milestone 2: Come out with a package that works												
Milestone 3 (*Expected Deliverable*)	1. Develop SQL based optimized search strategy												
	2. Integration												
	3. Test run												
	Validation for milestone 3: Come out with a package that works faster than the last one												
Milestone 4 (*Max deliverable*)	1. Implementation												
	2. Satisfaction survey												
	3. Comparative effectiveness assessment												
	Validation for milestone 4: Come out with a result from users of the new method for planning; effectiveness measures evaluated												

Deliverables

Deliverables	
Form of Deliverable	A python package of codes for head and neck therapy
Features	
Minimum Deliverable	A python package that works(generates optimized head and neck radiation therapy planning script for pinnacle 3).
Expected Deliverable	A python package that has an optimized searching method based on SQL to make the search and comparison go faster and more reliable.
Maximum Deliverable	Expected deliverable and the effectiveness of the new planning system evaluated

Dependencies

Dependencies	
Unresolved	Patient database access (have to discuss with Dr. McNutt to find a way)
Solved	Pinnacle 3 planning system
Solved	Existing codes(head and neck in matlab; searching queries in SQL; other part of body planning code in python; head and neck scripts generated from matlab)
Solved	Softwares

Management

Management Plan
1. Regular weekly meeting/consult with Dr. Mcnutt, Dr. Lehmann and Dr. Taylor
2. Update wiki pages regularly at weekends, documentation of the work done in the past week and the work that will be done in the following week
3. Report progress regularly to Dr. Mcnutt, Dr. Lehmann and Dr. Taylor via email
4. Go to the radiation oncology department at least once a week to get familiar with surroundings and personnels

References

1. [PUBLICATION] Wu B, Ricchetti F, Sanguineti G, et al. Patient geometry-driven information retrieval for IMRT treatment plan quality control. Med Phys. 2009 Dec; 36(12):5497-505.

2. [PUBLICATION] Wu B, Ricchetti F, Sanguineti G, et al. Data-Driven Approach to Generating Achievable Dose-Volume Histogram Objectives in Intensity-Modulated Radiotherapy Planning. Int J Radiat Oncol Biol Phys. 2010 Aug 26. [Epub ahead of print]

3. [PUBLICATION] Simari P, Wu B, Jacques R, et al. A statistical approach for achievable dose querying in IMRT planning. Med Image Comput Comput Assist Interv. 2010;13(Pt 3):521-8.

4. [PUBLICATION] Kazhdan M, Simari P., McNutt T., et al. Shape Matching for Retrieval in Patient Databases. Comput Graphics, 1981; 0(0): pp. 1-5.

Thank You

- Many thanks to Dr. Taylor who encouraged me in doing this;
- Many thanks to Dr. McNutt and Dr. Lehmann to support this project and gave many advices;
- Many thanks to everyone who is still sitting here right now and tolerating my presentation.
- Any questions?