Advanced CIS (600.446)	Spring, 2011	JH SOM
		JHU CS
		JHH Radiation Oncology

Project Proposal

Project Title	Data Driven Strategy for Optimized IMRT planning for Head and Neck Radiation Oncology Therapy		
Time Frame	Spring 2011 (2/18/2011 -- 5/17/2011)		
Project Summary	Using Overlapped Volume Histogram (OVH) as a parameter for representing distance distribution was proposed as a new data-driven strategy for optimal Intensity-Modulated Radiation Therapy (IMRT) planning in JHH Radiation Oncology Department. Coding modules based on Matlab and SQL has been developed, there has been existing thoracic therapy planning based on python code. There is a practical need for modifying python code for head and neck radiation therapy, and integrating existing matlab code and SQL queries to promote optimized searching strategy for IMRT planning.		
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Date Prepared	February 18th, 2011		

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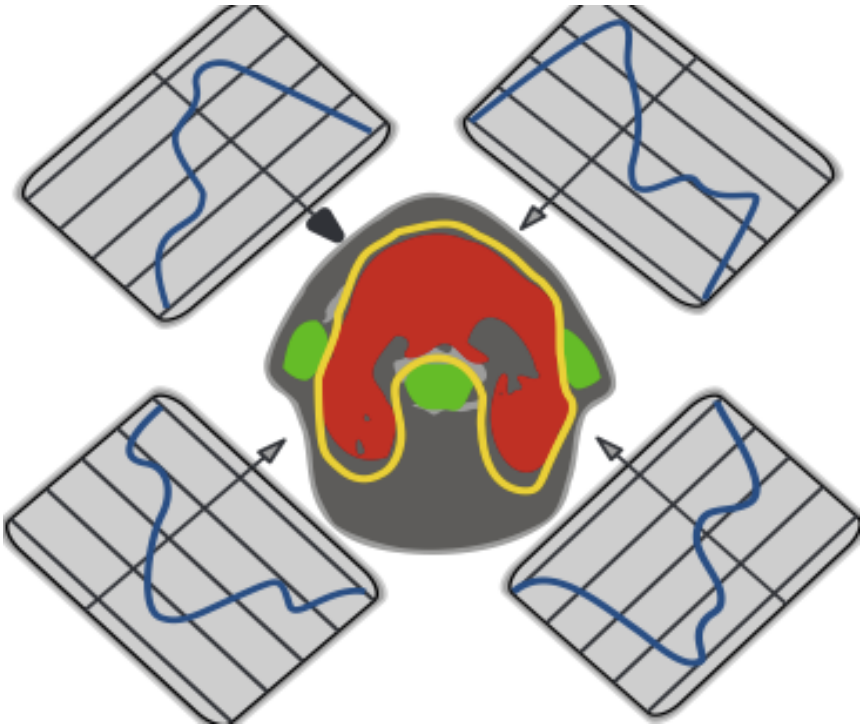
Proposal project number: 11

Project Description

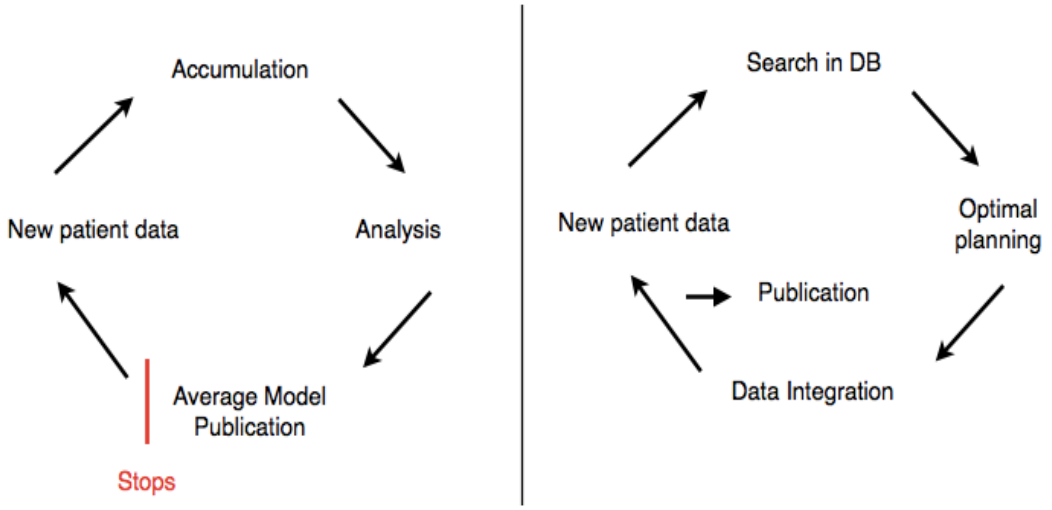
Background and Significance

Intensity-Modulated Radiation Therapy(IMRT) is a radiation based therapy used mainly for oncological diseases, the therapy itself use a set of beams with the feature that the radiation intensity of each beam can be modified to achieve different distribution of strength within each beam:



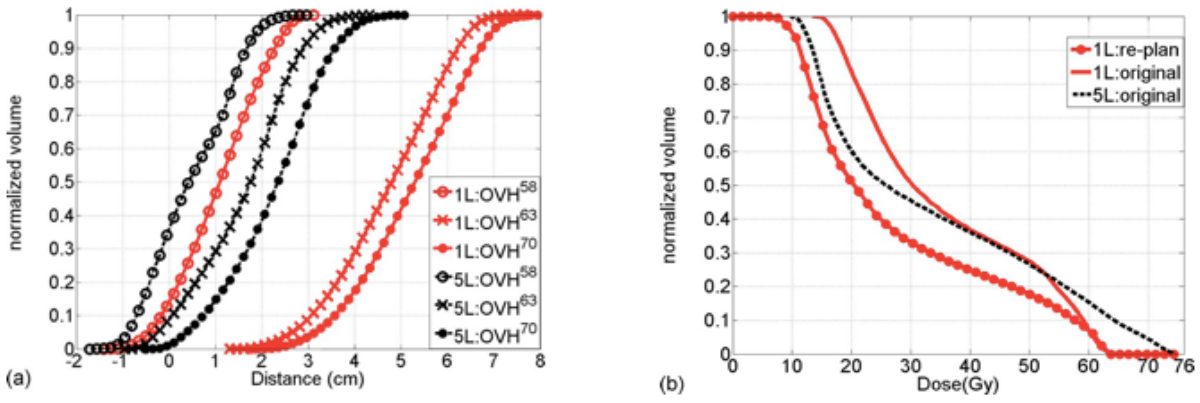
According to the Dose- Volume Histogram (DVH) chosen by the planners, the intensity distribution of each beam is different to satisfy the radiation need for the Planning Target Volume (PTV), and at the same time, spare the Organ At Risk (OAR).

Former approaches to plan an IMRT takes time and needs individual planner experiences, there are, however, multiple methods based on statistical analysis to improve the planning process. However, such analytical results are based on a large number of sample and only focus on “average planning”, which may not apply to individual cases, and the uncertainty of success is still high; in addition, such attempts take no respect to dynamic accumulation of experiences, usually most analyses take a certain time period as a point, get the results, and the cycle ends; for up-to-date results, it would usually take years as large trials or data analysis takes time and is costly. In this scenario, we propose a new method on a data cycling basis that the data of every new patient has a tendency to affect the treatment plan of the next patient:



Knowledge Maintenance Cycle

The goal of optimal planning using statistical modeling methods are extremely difficult because of the shape variation of organs in different human body, and also because of the random movement of the target. Currently, most planners have to manually do the planning of each beam based on experience and simulations, which usually takes a long time and may not come out with an optimized plan. A new method of planning based on a parameter of Overlap Volume Histogram(OVH) and data driven approach is therefore introduced for safety and efficiency issues. OVH is a parameter introduced to represent the practical distance distribution from the PTV and the OAR, it is a volume calculation of the OAR based on the measurement of distance extended from the PTV. On the same distance extended, the larger the OVH, the nearer the OAR is to the PTV. We can therefore create a diagram of OVH with the distance of extension of PTV as the X axis and Overlapped volume at the Y axis. For each volume point of OVH, we can then have different volume of OAR and map the respective volume to dose in a DVH. So now we can get the data as for every volume point of OAR, the respective dose it would get in the plan:



Courtesy of Dr. Todd McNutt and Wu Binbin

A logical assumption underlying is that the larger the distance between the OAR and PTV, the easier the OAR can be spared. In order to find the optimal plan, we first create an OVH and DVH diagram of the current plan of current patient, see if there are former patients that have a larger OVH at the same distance, find all of those patients, map all diagrams to DVH, and search for the minimum dose that can be achieved. If there are patients that have a larger OVH at the same distance, but have a lower dose at the same volume, then at least such a dose level at the specific volume can be achieved because the former patients are harder to plan than the current, but receives a smaller dose at the same volume. Each specific intensity of target PTV is searched, and each beam is modified, the search can then generate a optimized plan for the patient, and the new plan of the current patient is then stored into the database as a new piece of information. In this way, we can make use of the data of every patient dynamically, make the planning process faster, and achieve a more and more optimized (safety and quality) plan as the database grows.

Searching codes based on python have been created for different parts of the body. We need a planning package for head and neck therapies. Such code have already been created on matlab, but to consider the practical need of the radiation oncology department, we need to create a package based on python.

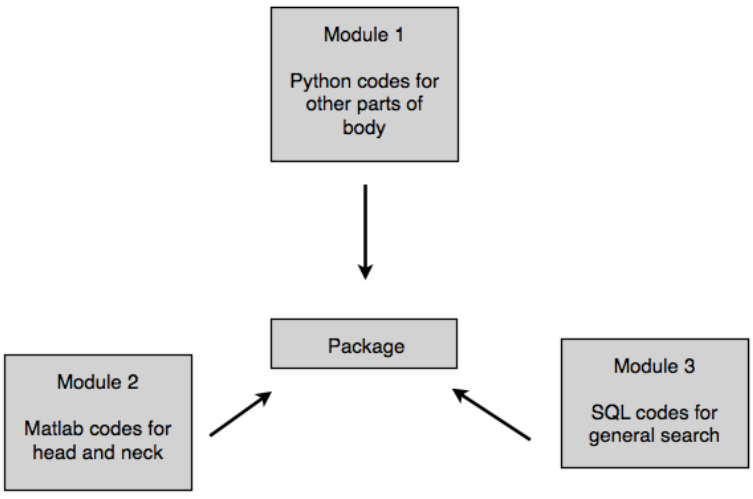
Goals

Create a data driven IMRT planning package based on python and SQL.

Technical Approach

There are three major tasks in this project:

- Modify existing python codes that are used on thoracic therapy for head and neck therapy.
- Integrate existing matlab code into the modified python code
- Integrate SQL search strategies into the modified python code to promote faster search



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 evaluation of effectiveness delivered

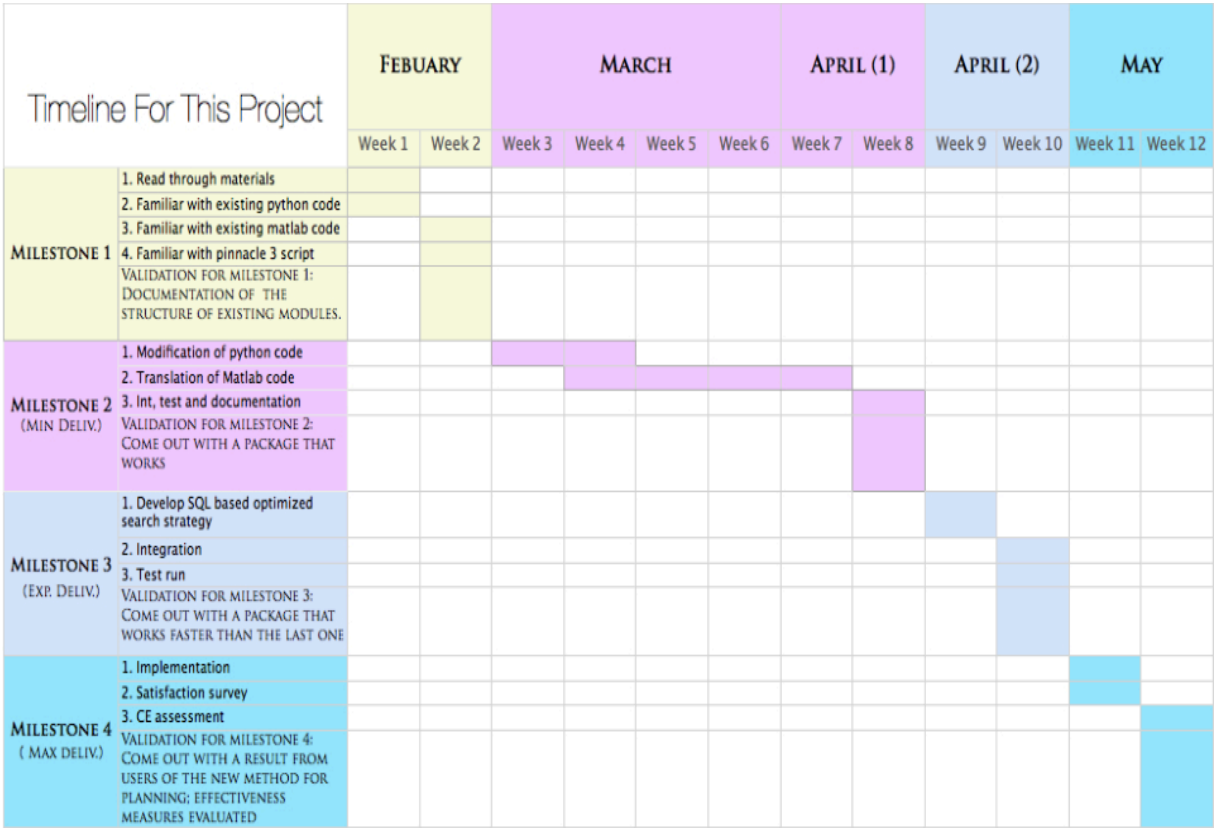
Dependencies

Dependencies	
Unresolved	Patient database access (looking for Dr. McNutt to resolve)
Solved	• Pinnacle 3 • Existing codes (Matlab, python, SQL) • Softwares (Matlab, python, SQL)

Management Plan

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

Timeline



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.