

A Data-Mining Algorithm for Large Scale Analysis of Dose-Outcome Relationships in a Database of Irradiated Head and Neck Cancer Patients

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AAPM Young Investigator Symposium 2014



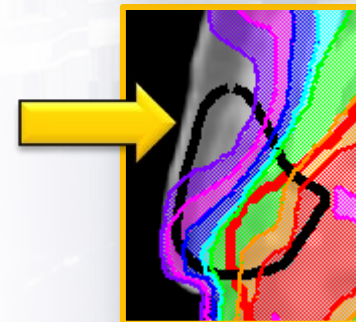
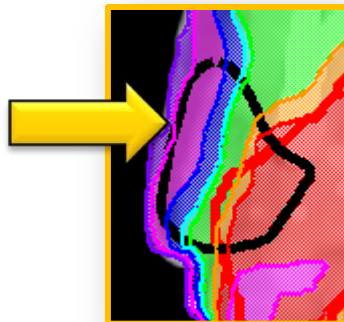
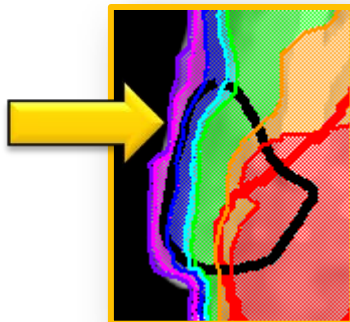
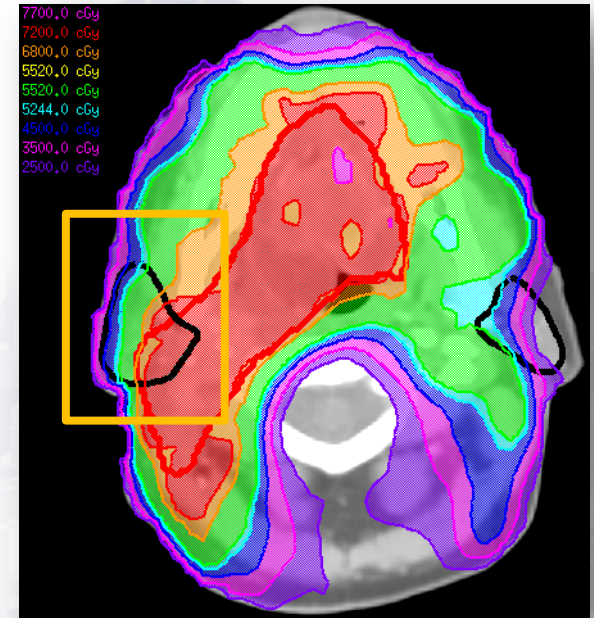
JOHNS HOPKINS
M E D I C I N E

Disclosure

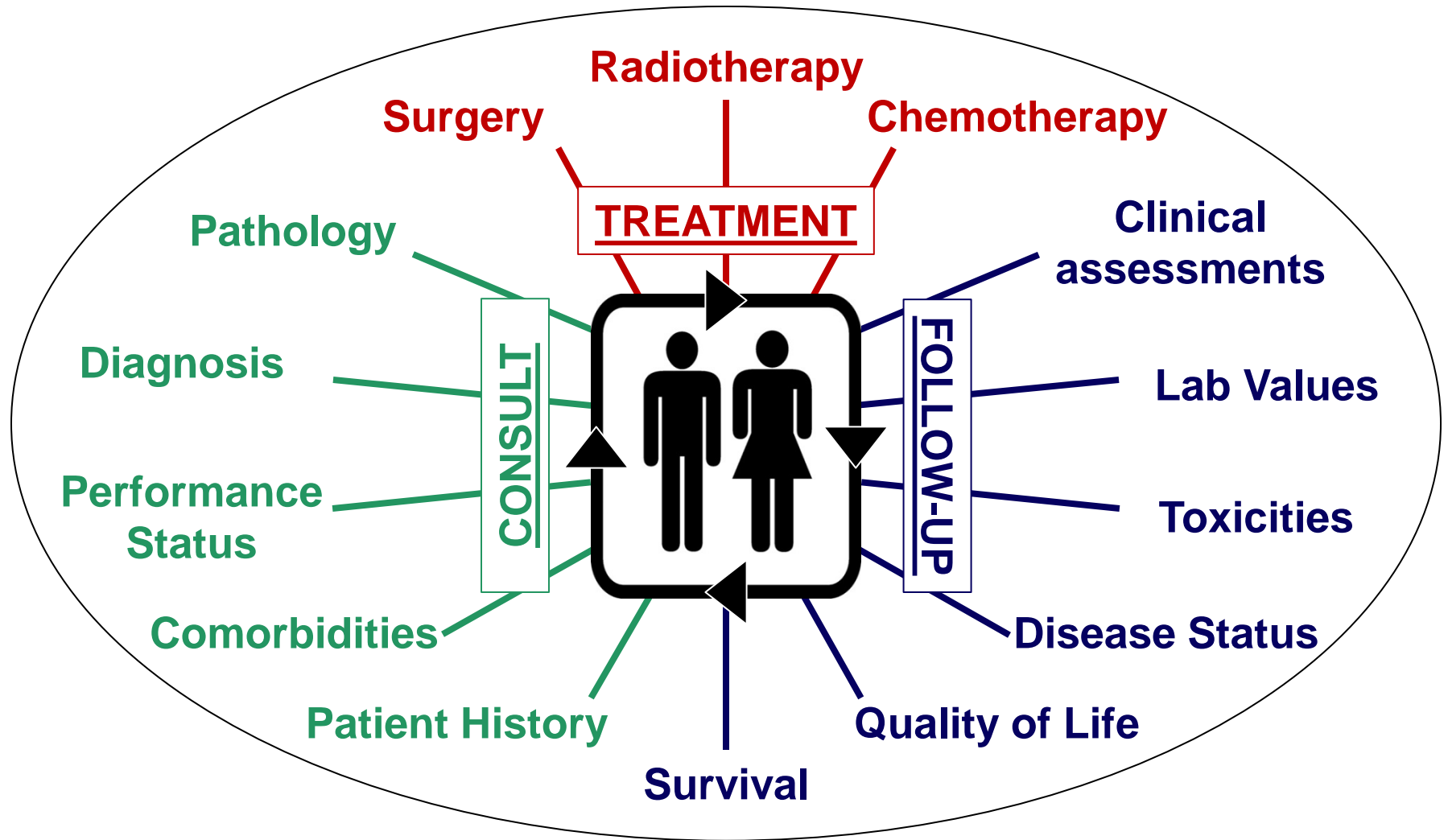
- This work supported by:
 - Philips
 - Commonwealth Foundation

Introduction

- High accuracy in modern radiation treatment planning and delivery
- Large variability in normal tissue response



Oncospace: An analytic oncology database

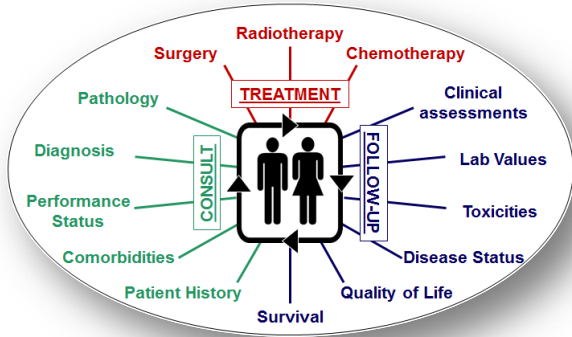


Purpose

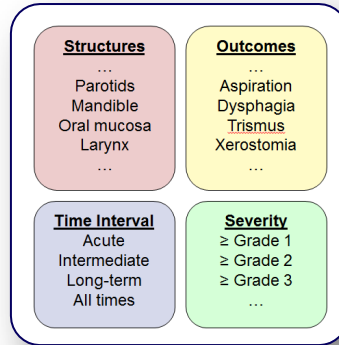
- Analysis: Develop framework for dose-toxicity analysis and review
- Data-Mining: Search Oncospace for notable dose-toxicity relationships

Data Mining – Overview

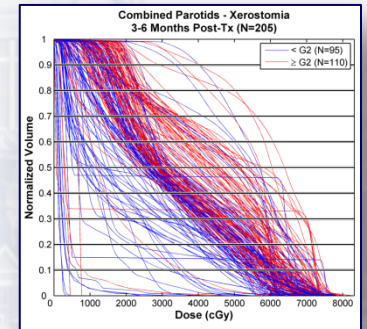
Oncospace



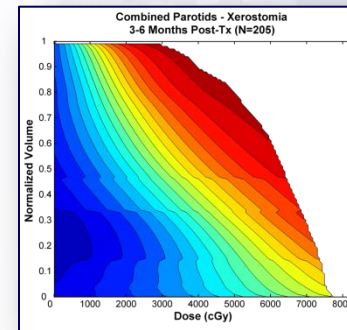
1. General analysis parameters



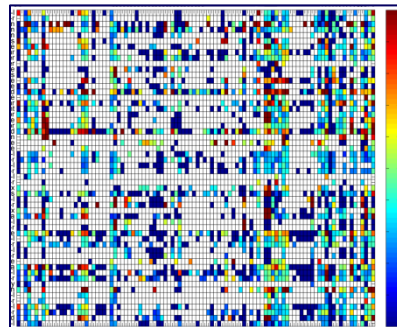
2. Specific analysis parameters



3. Analysis



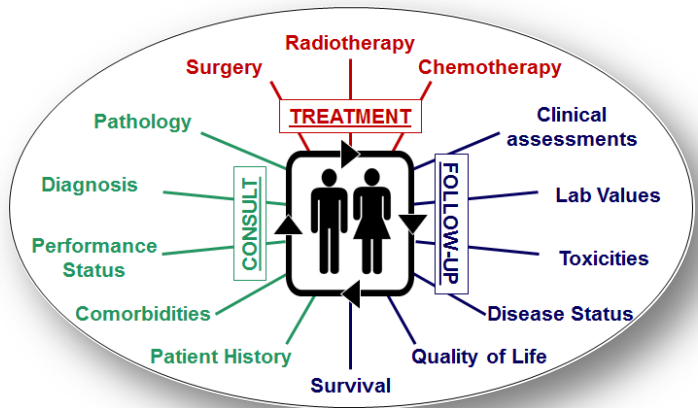
4. Review



Data Mining

1. General Parameters

Oncospace



Structures

...
Parotids
Mandible
Oral mucosa
Larynx
...

Outcomes

...
Aspiration
Dysphagia
Trismus
Xerostomia
...

Time Interval

Acute
Intermediate
Long-term
All times

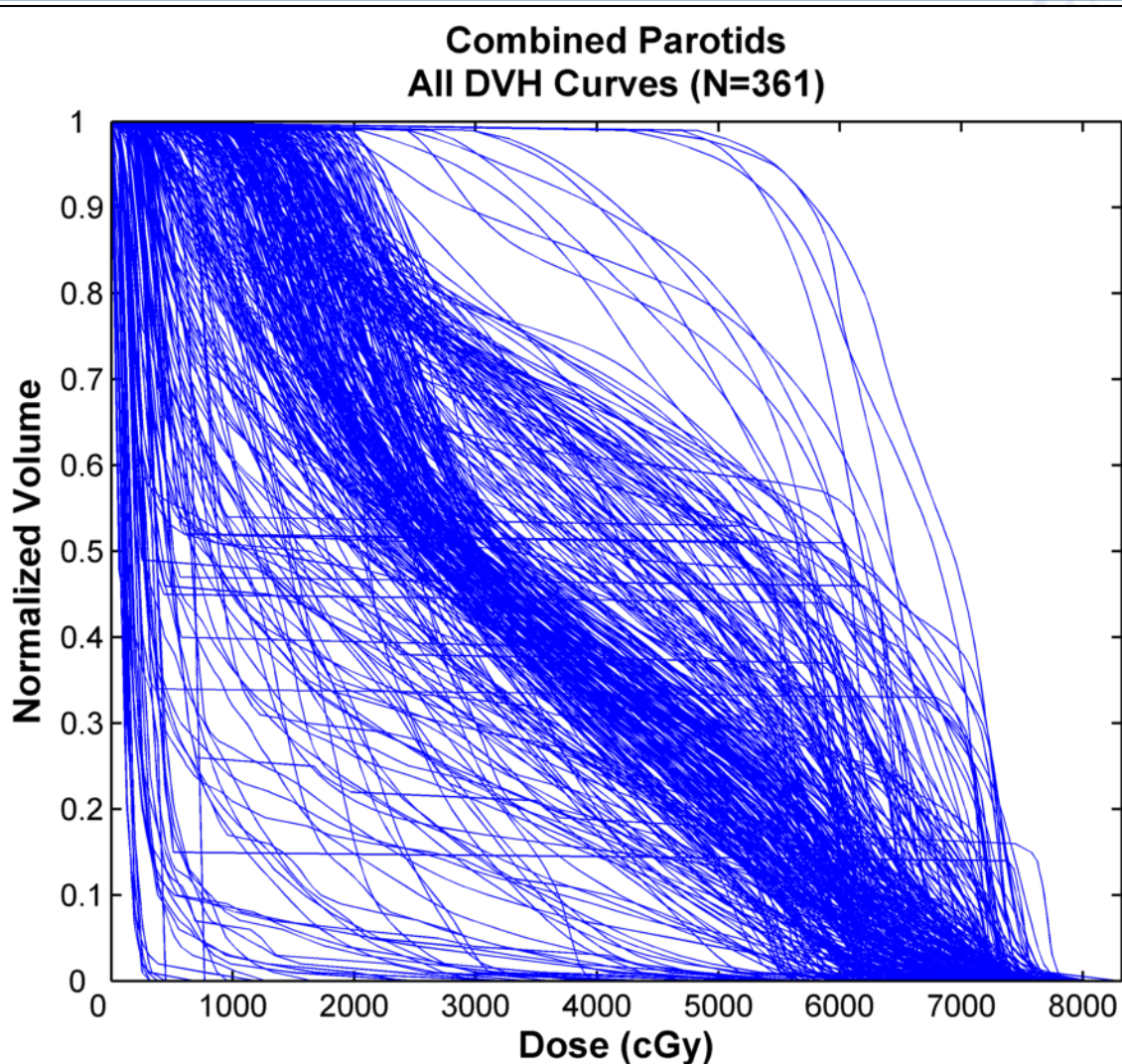
Severity

≥ Grade 1
≥ Grade 2
≥ Grade 3
...

Data Mining

2. Analysis-Specific Parameters

- Que



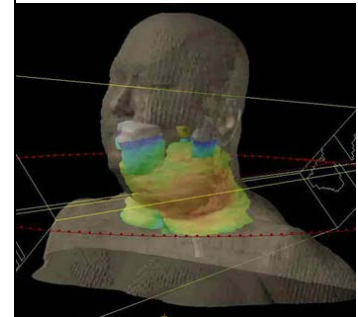
Parotids

Xerostomia

Acute

\geq Grade 2

3D Dose



Data Mining

2. Analysis-Specific Parameters

- Query and process dose data

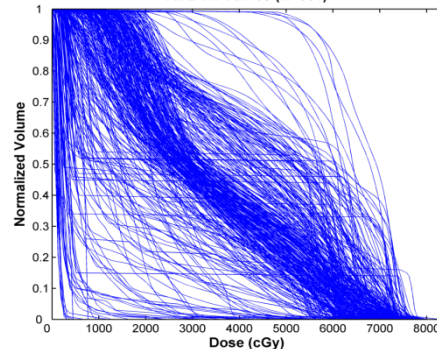
Parotids

Xerostomia

Acute

≥ Grade 2

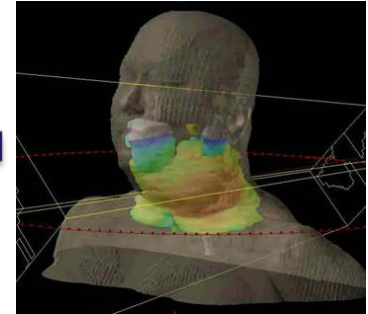
DVH Curves



3D Structures



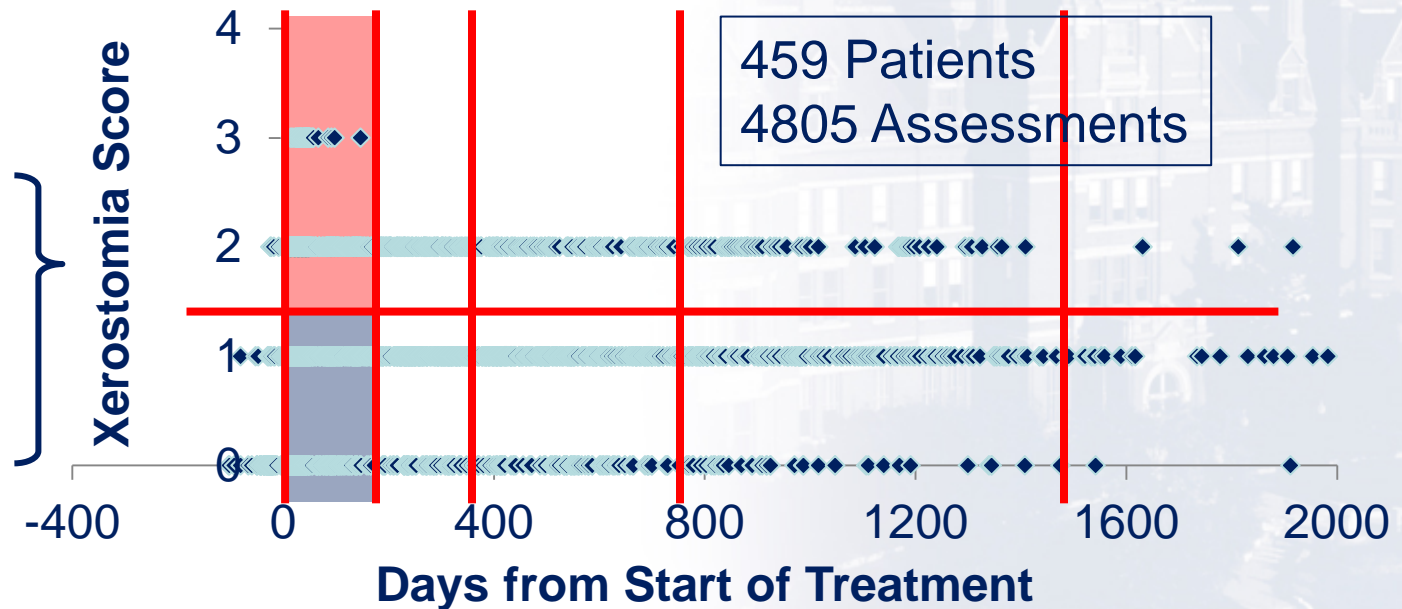
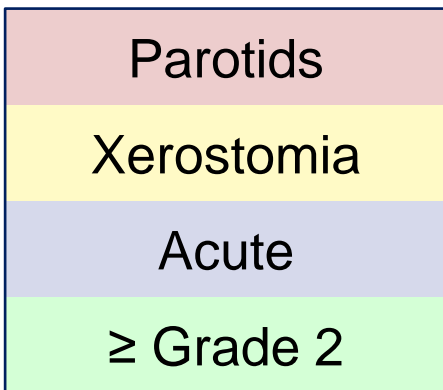
3D Dose



Data Mining

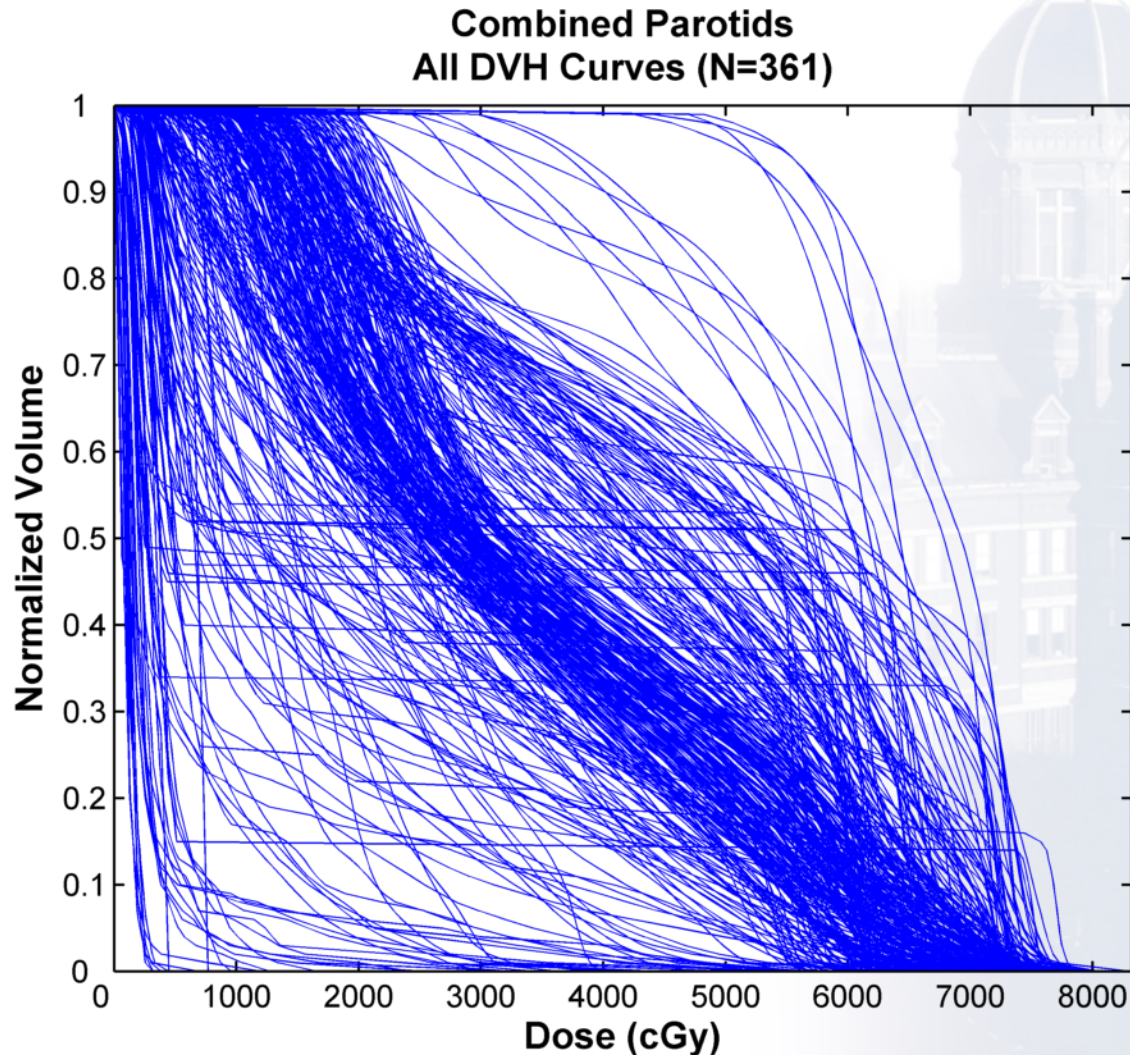
2. Analysis-Specific Parameters

- Query and process dose data
- Process toxicity data



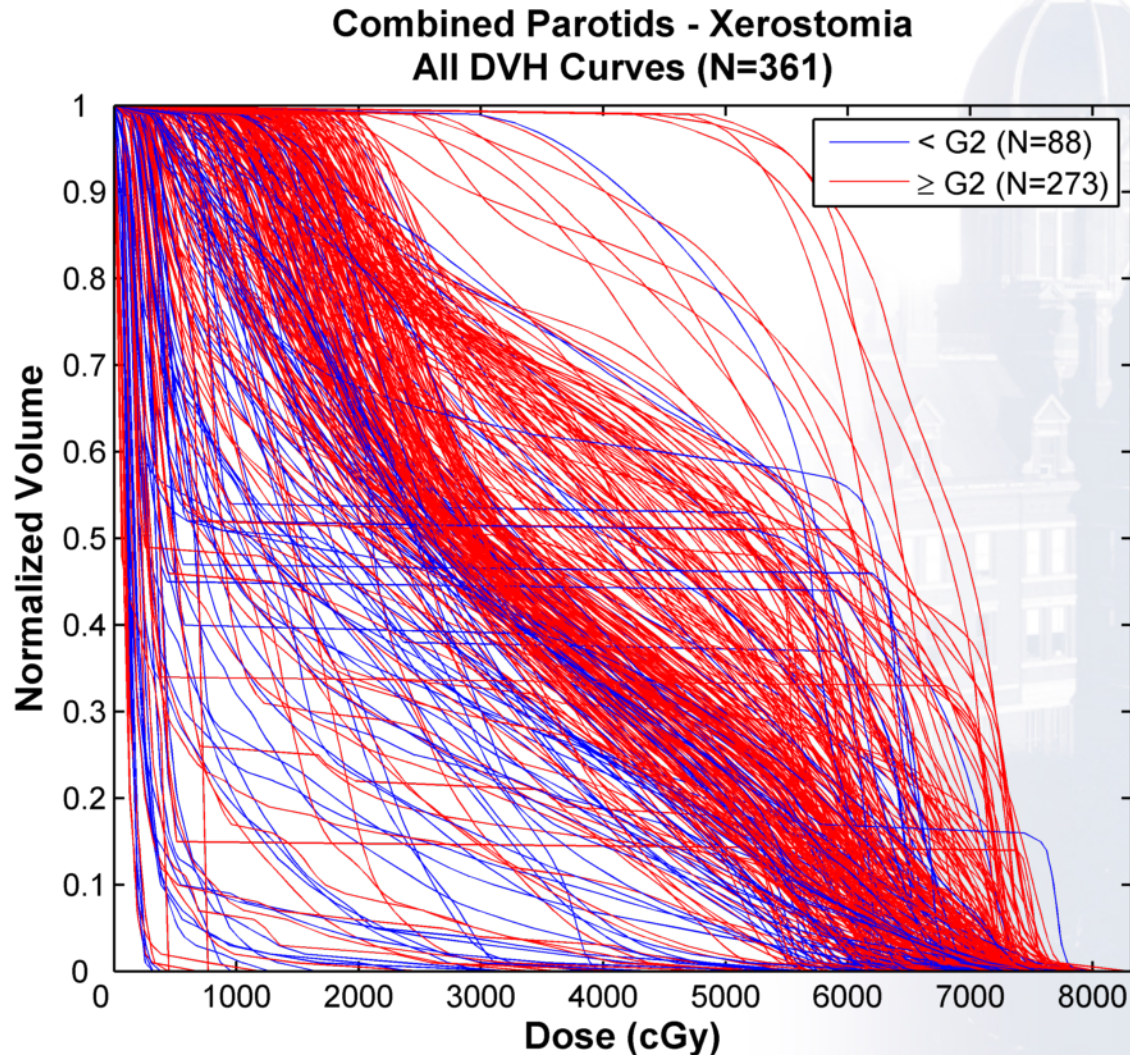
Data Mining

2. Analysis-Specific Parameters



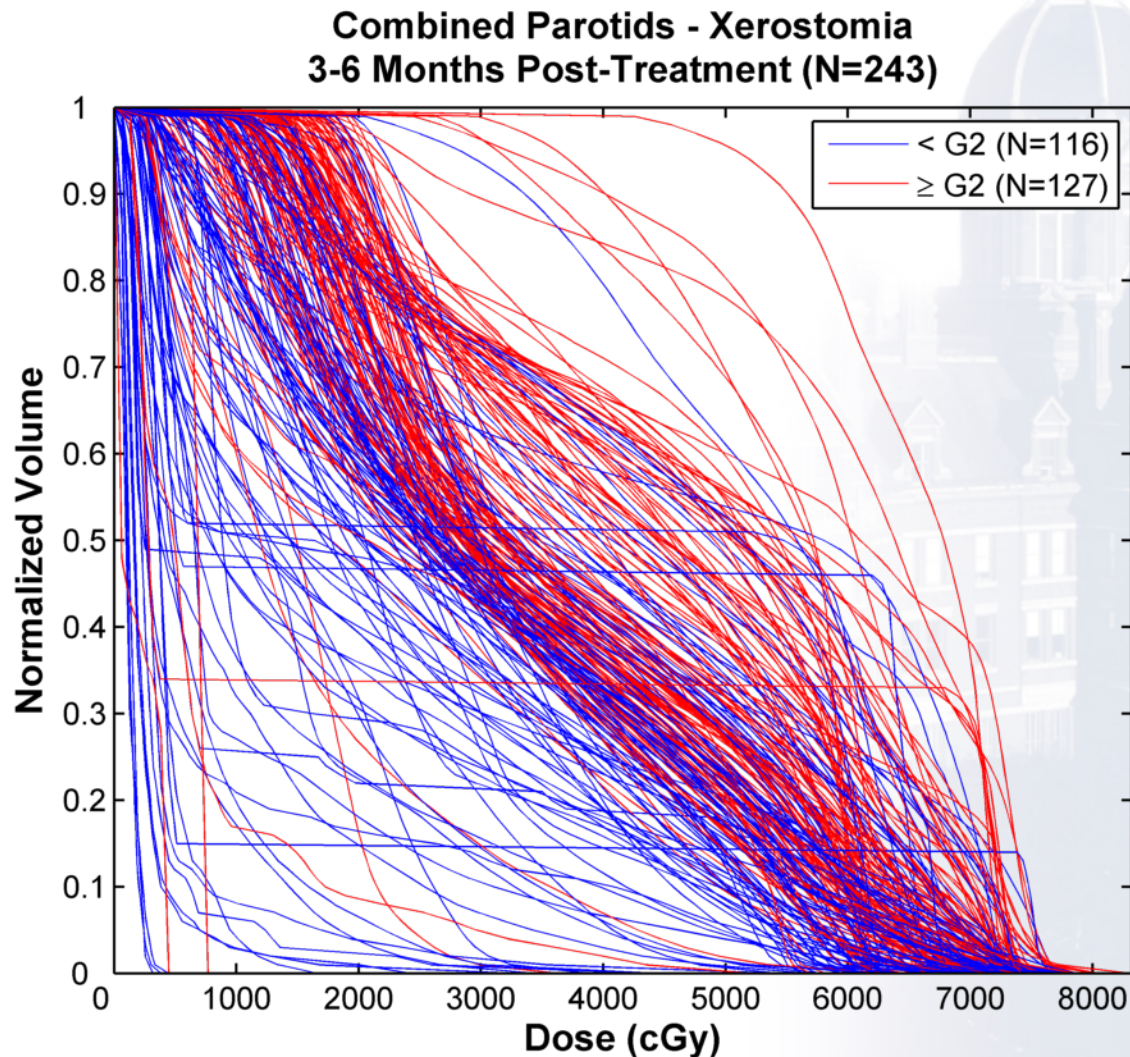
Data Mining

2. Analysis-Specific Parameters



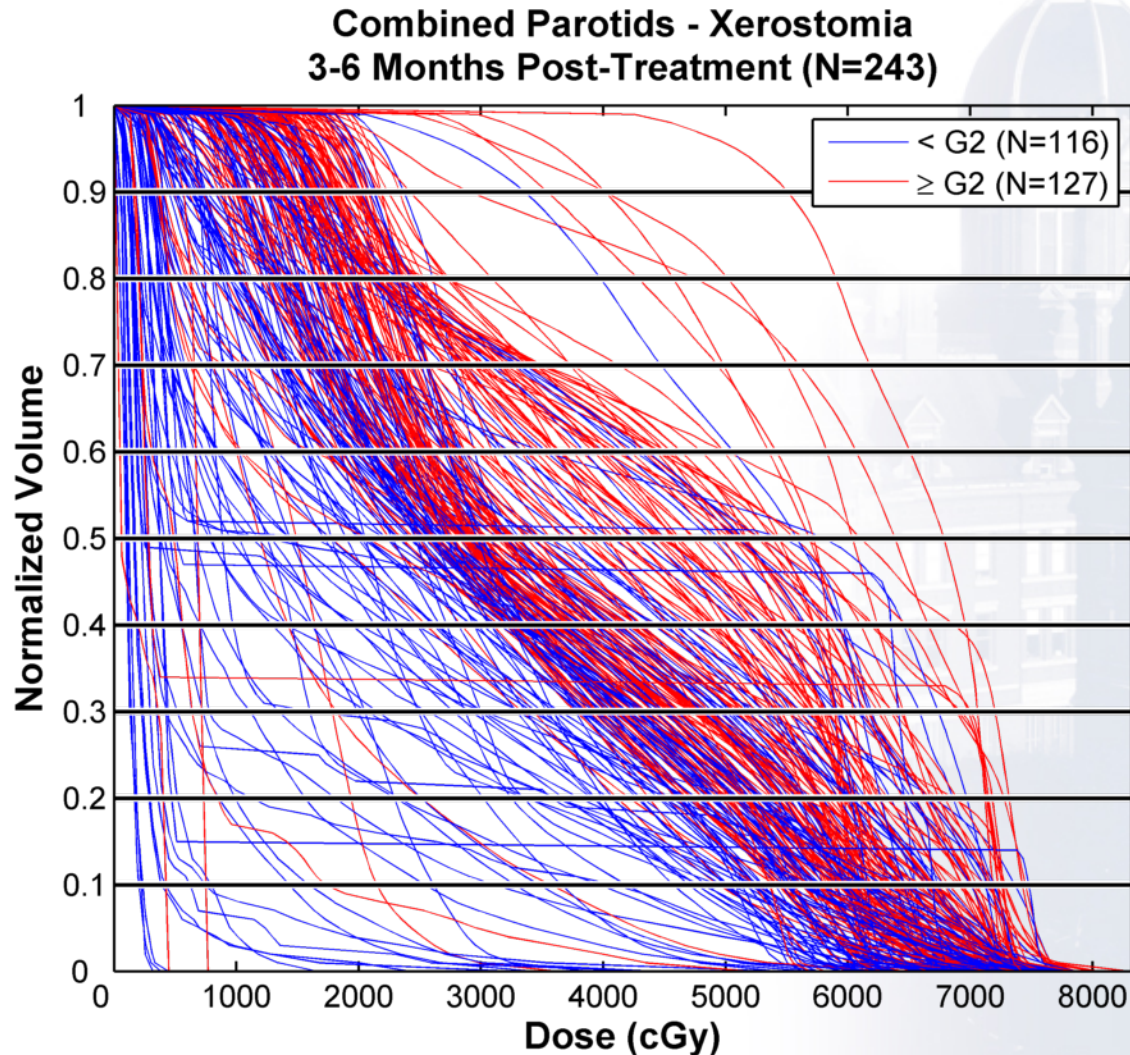
Data Mining

2. Analysis-Specific Parameters



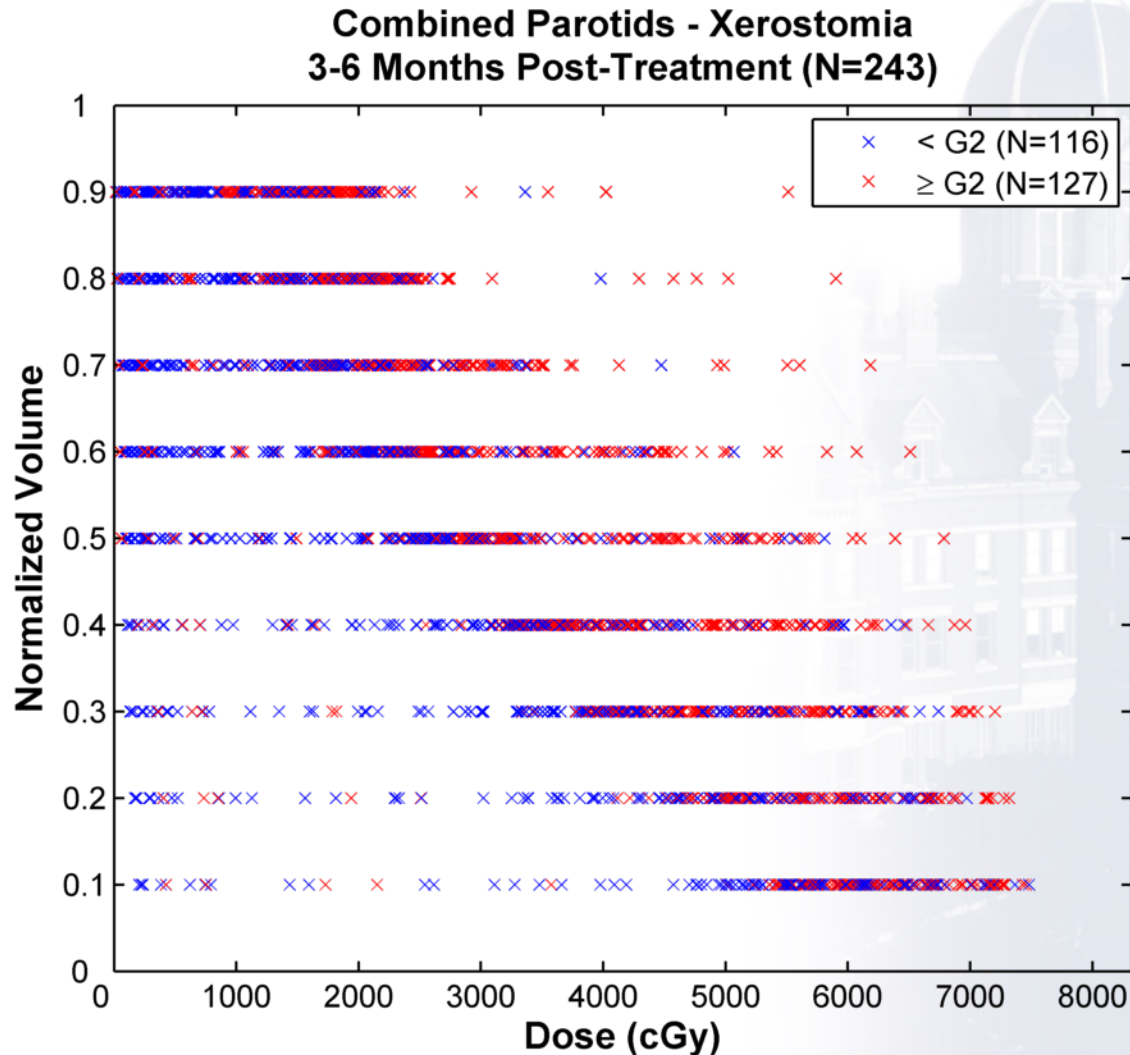
Data Mining

2. Analysis-Specific Parameters



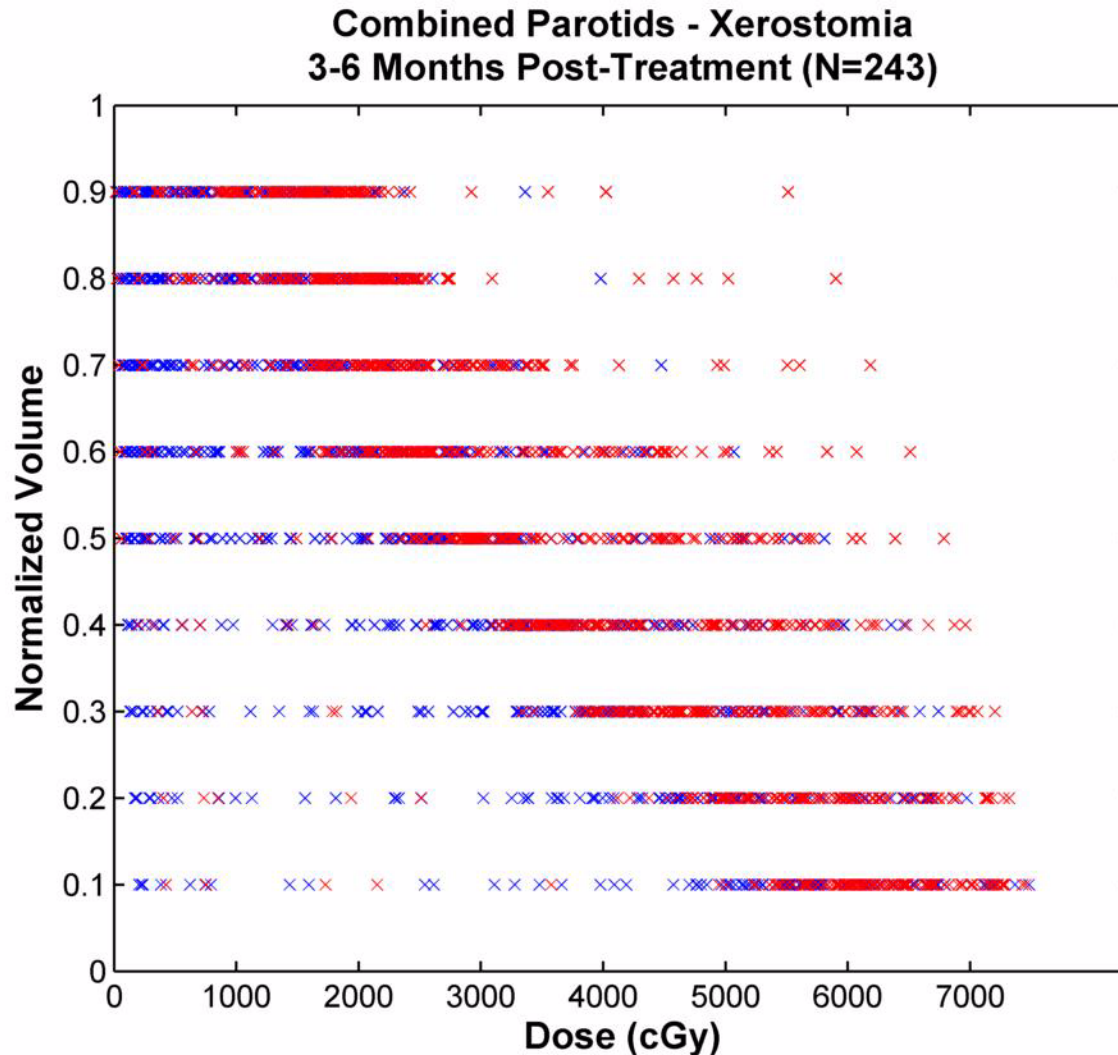
Data Mining

2. Analysis-Specific Parameters



Data Mining

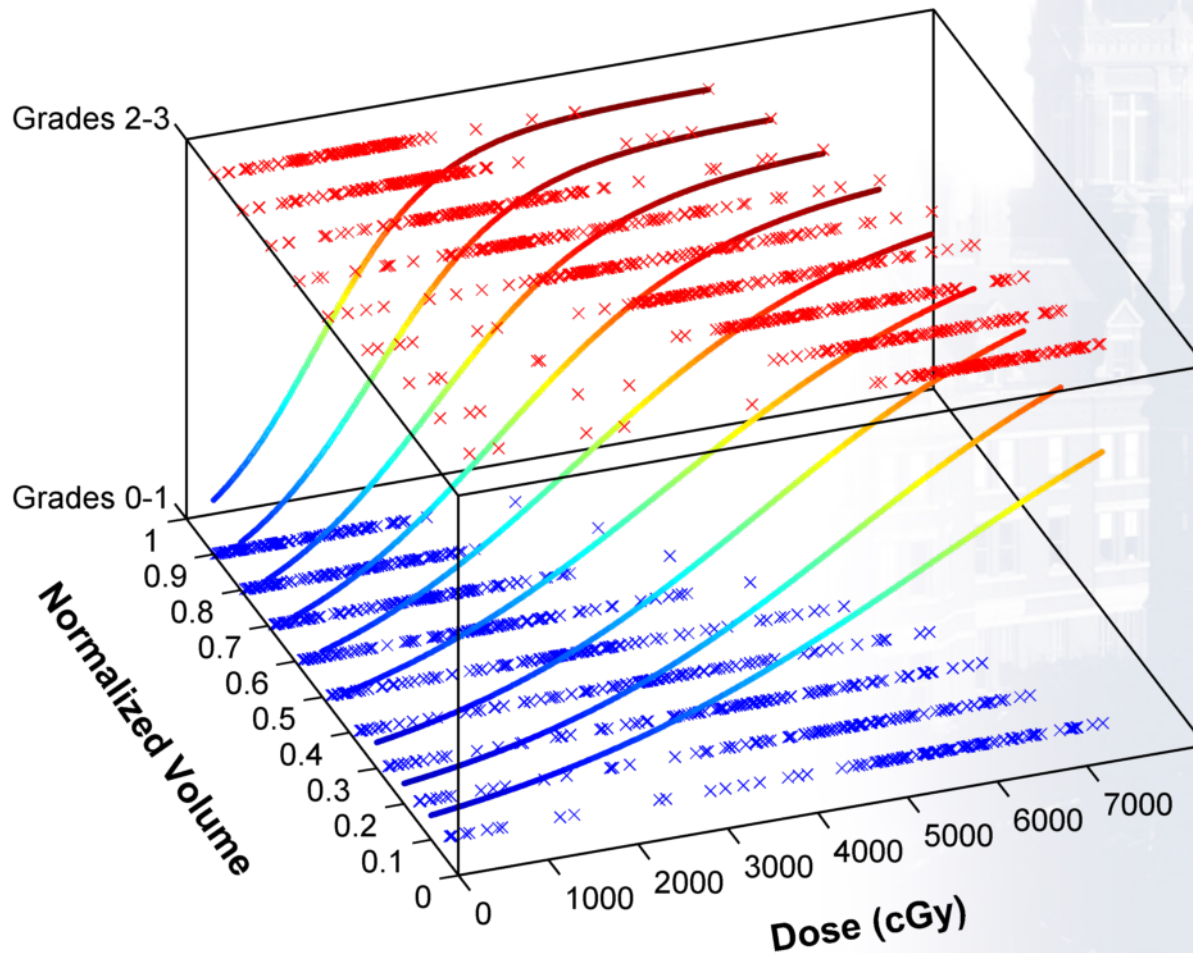
2. Analysis-Specific Parameters



Data Mining

3. Analysis

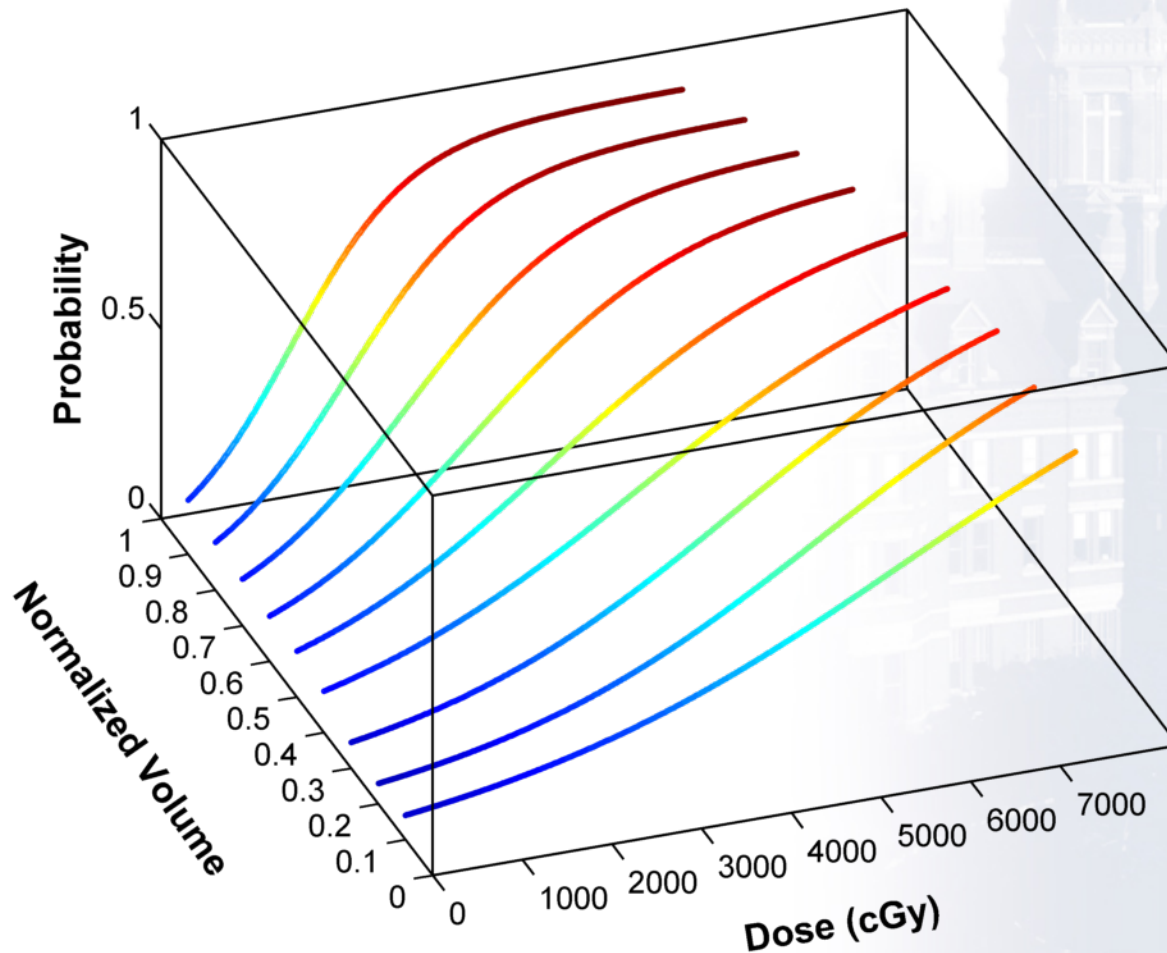
Combined Parotids - Xerostomia
3-6 Months Post-Treatment (N=243)



Data Mining

3. Analysis

Combined Parotids - Xerostomia
3-6 Months Post-Treatment (N=243)

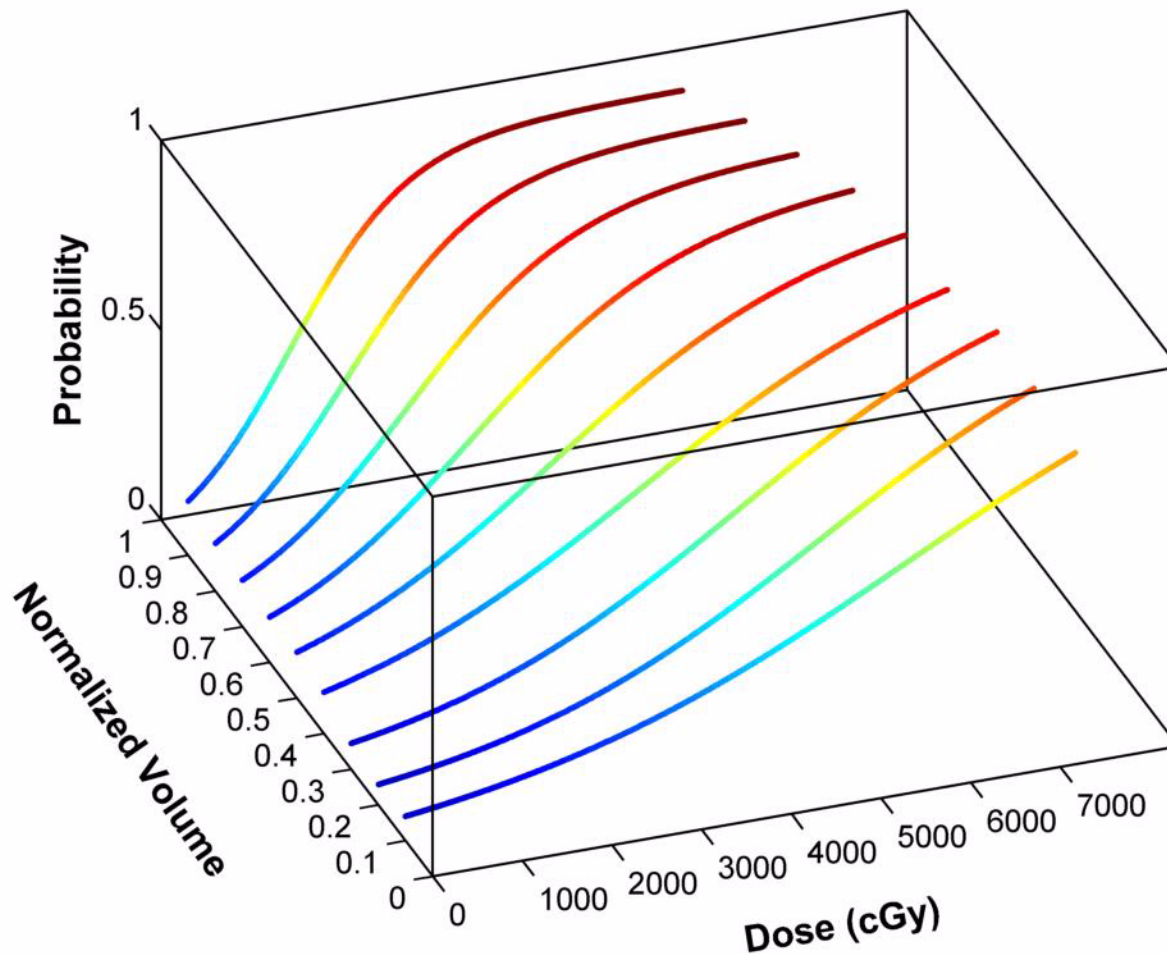


Data Mining

3. Analysis

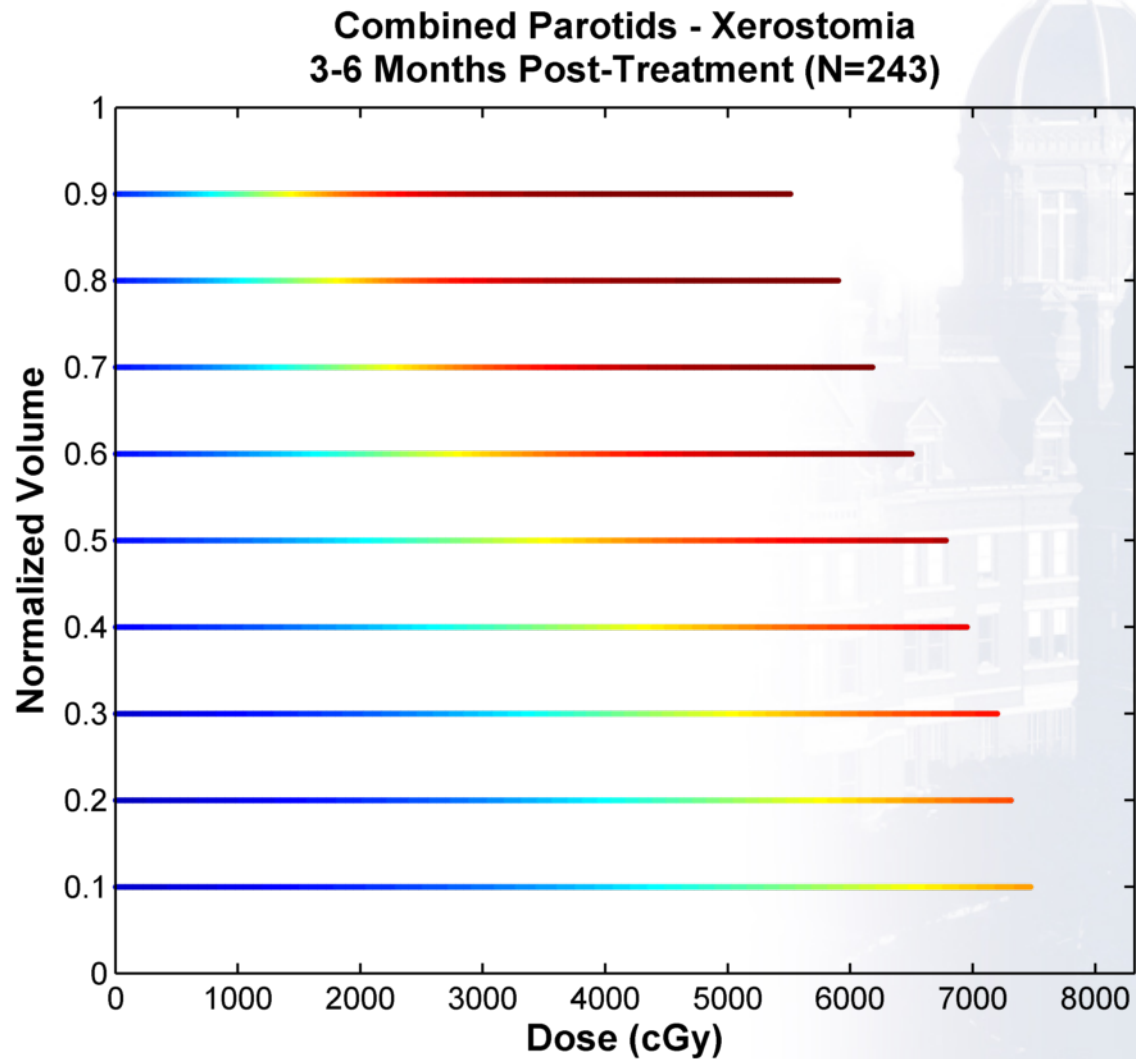


Combined Parotids - Xerostomia
3-6 Months Post-Treatment (N=243)



Data Mining

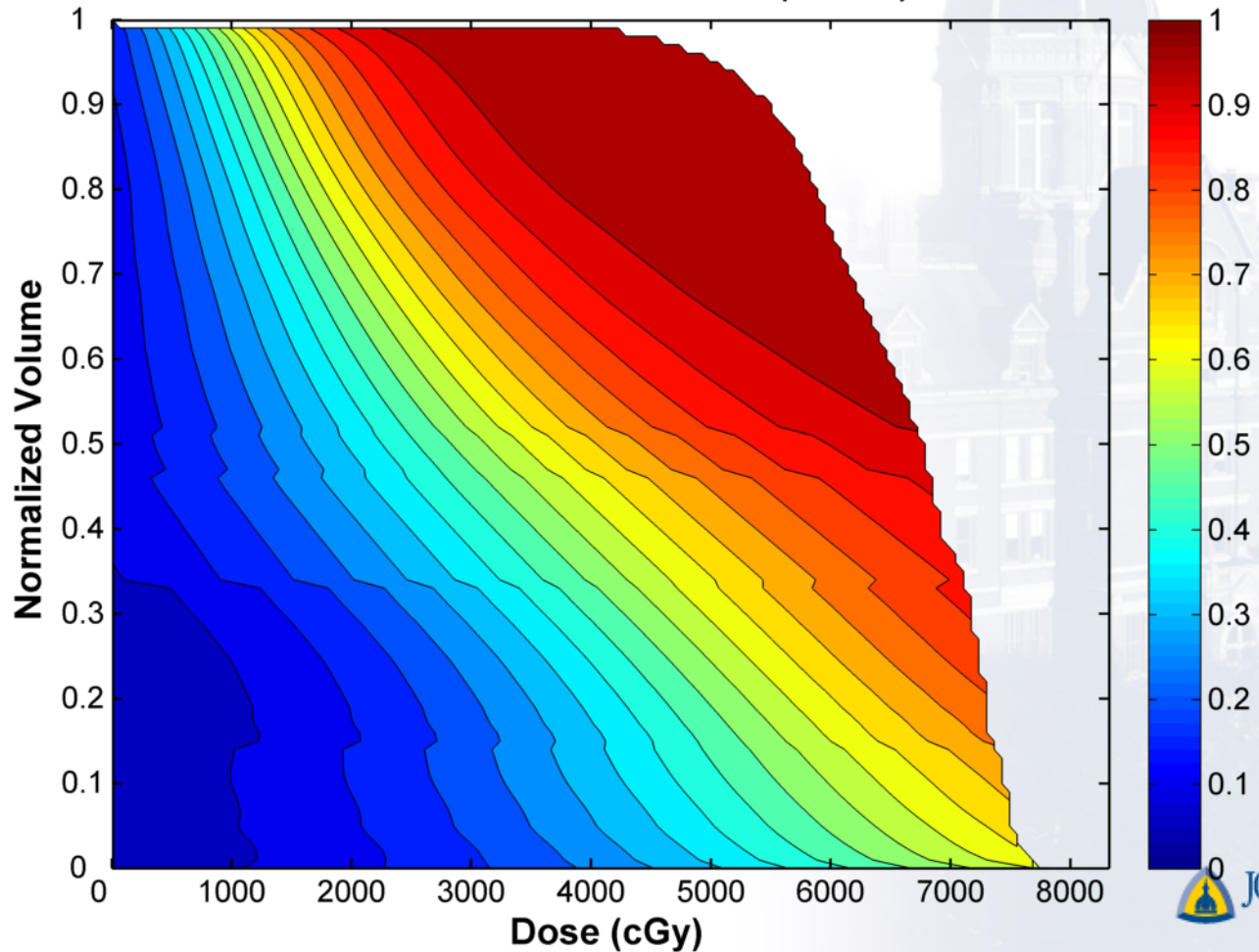
3. Analysis



Data Mining

3. Analysis

Combined Parotids - Xerostomia
3-6 Months Post-Treatment (N=243)



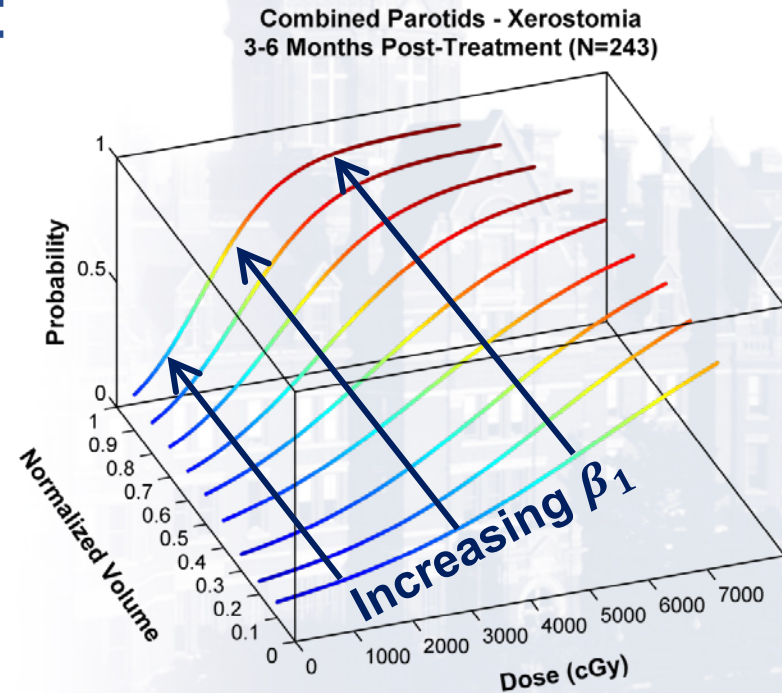
Data Mining

3. Analysis

- Univariate logistic regression:

$$f(x) = \frac{1}{1 + \exp[-(\beta_0 + \beta_1 x)]}$$

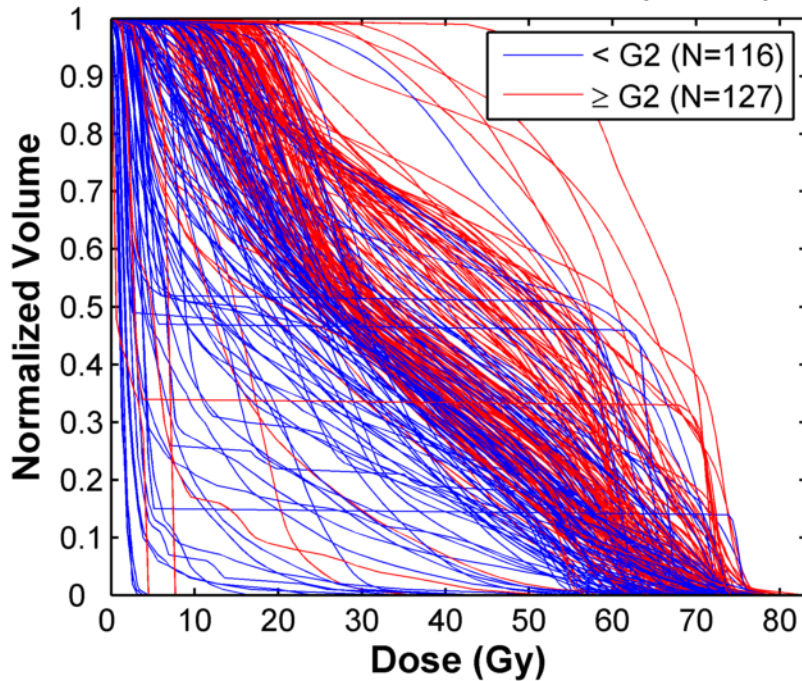
- β_1
 - Reflects curve steepness
 - $\Delta(\log \text{ odds})$ per unit dose
- $\exp(\beta_1)$
 - $\Delta(\text{Odds})$ per unit dose
 - Higher “ $\exp(\beta_1)$ ” reflects stronger influence of dose on toxicity



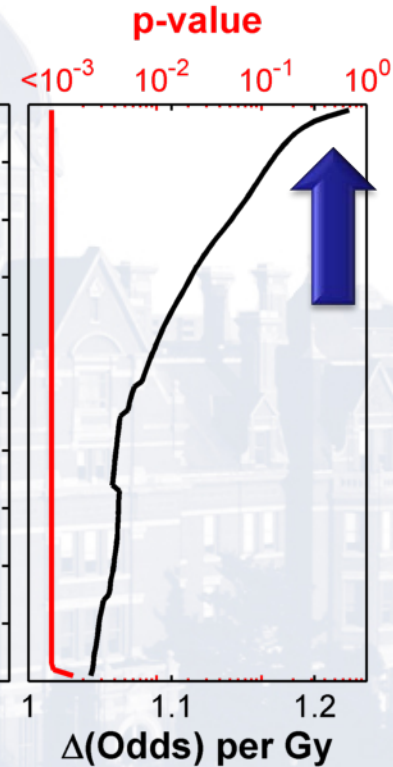
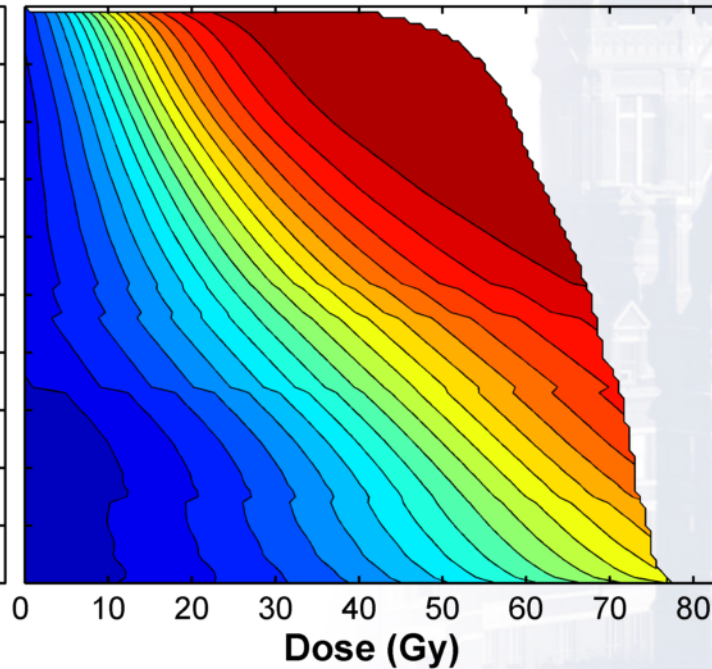
Data Mining

4. Review

Combined Parotids - Xerostomia
3-6 Months Post-Treatment (N=243)



Combined Parotids - Xerostomia
3-6 Months Post-Treatment (N=243)

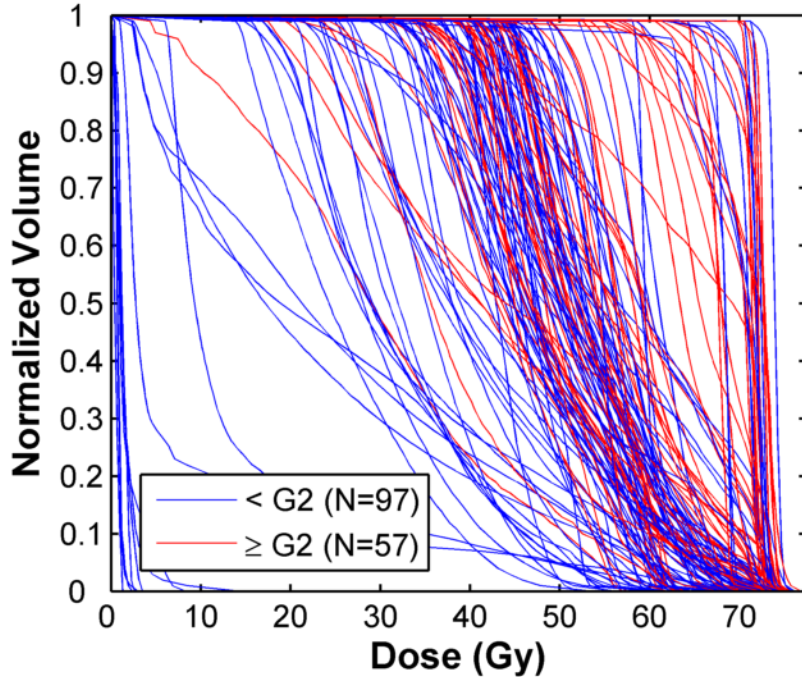


At 99% Volume, 1.224 = 22.4% change in odds per Gy

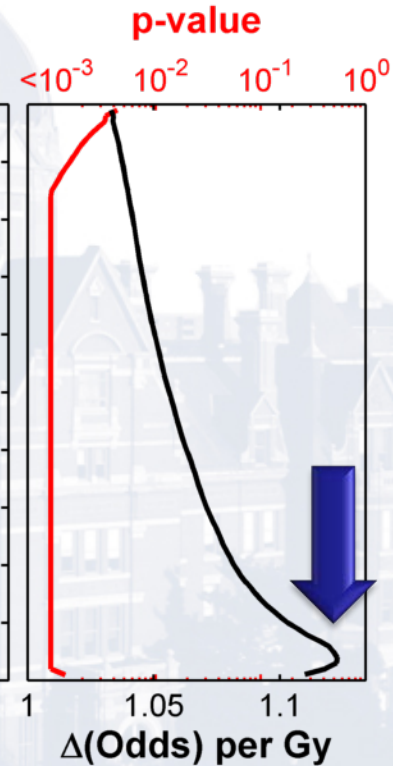
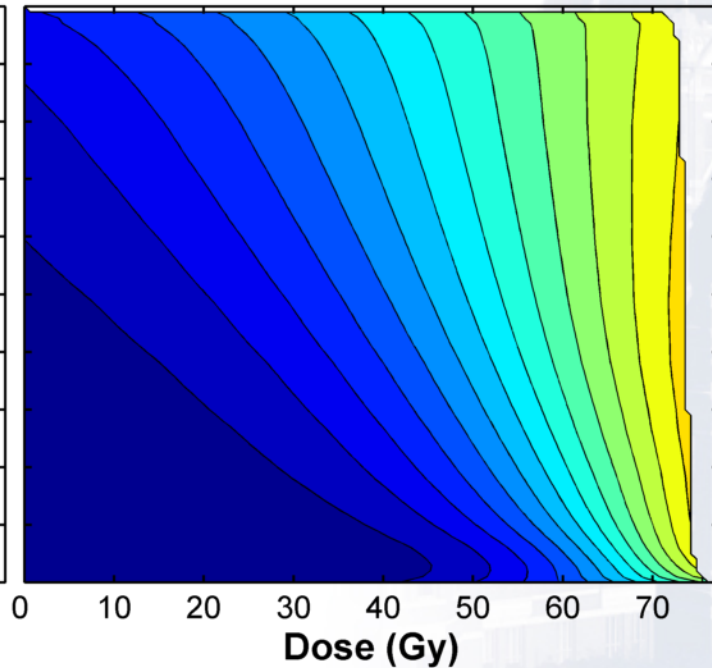
Data Mining

4. Review

Larynx - Dysphagia
0-12 Months Post-Treatment (N=154)

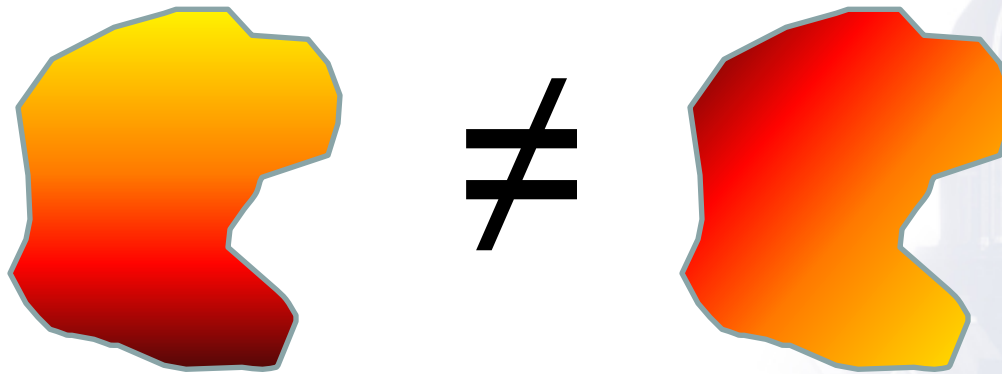


Larynx - Dysphagia
0-12 Months Post-Treatment (N=154)



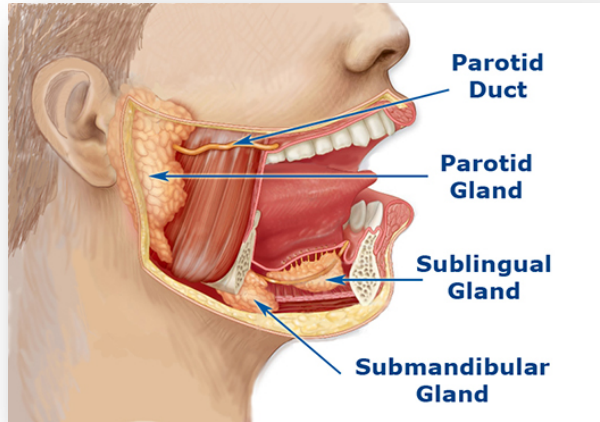
At 5% Volume, 1.121 = 12.1% change in odds per Gy

Bad DVH!

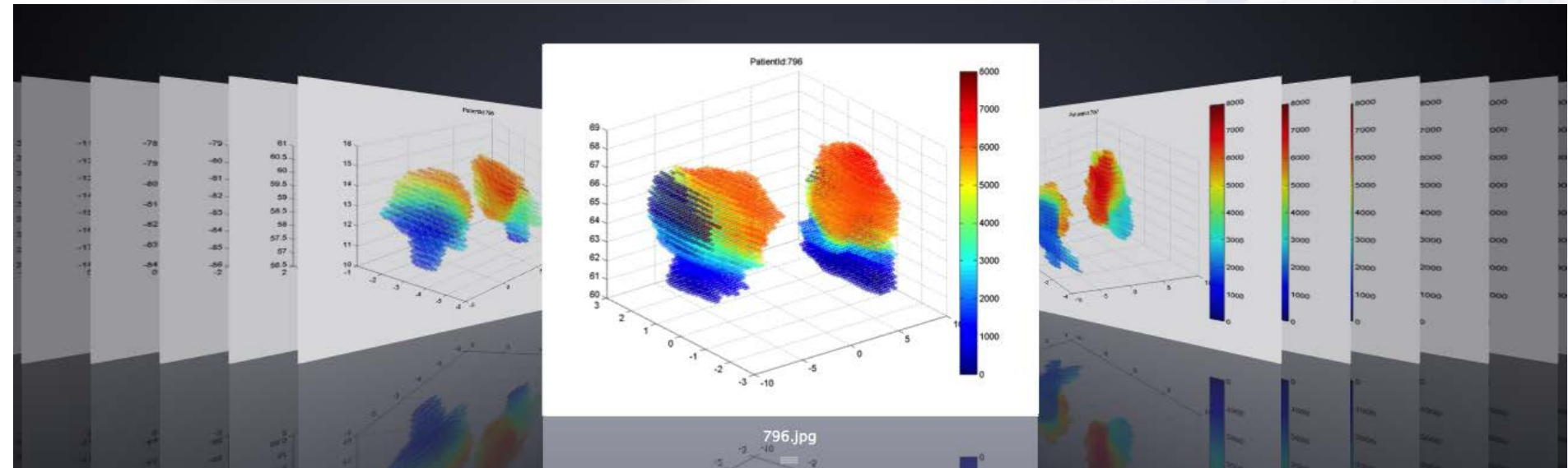
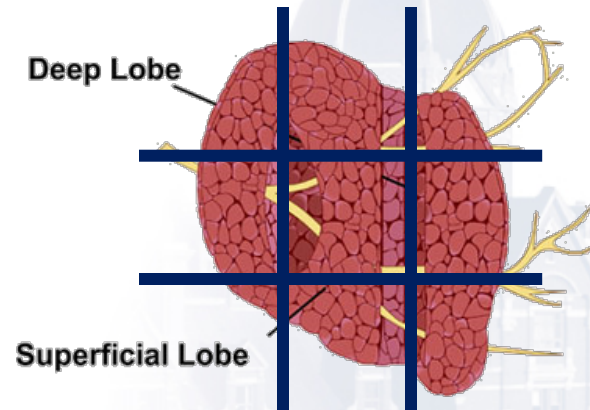


- DVH assumes that every sub-region of an OAR has the same radiosensitivity and functional importance to the related toxicity
- DVH assumes that each OAR is uniquely responsible for the overall human function related to the toxicity

3D Dose-Toxicity Modeling

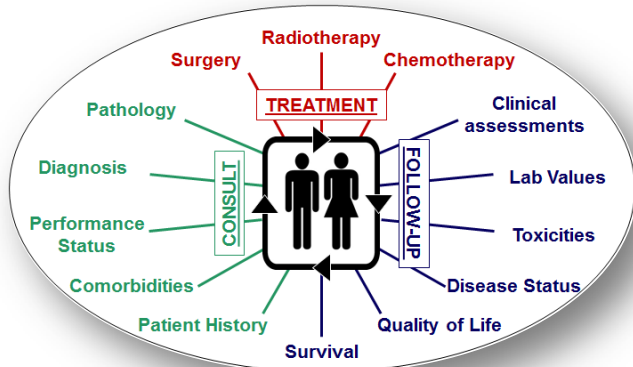


The Parotid Gland and Facial Nerve

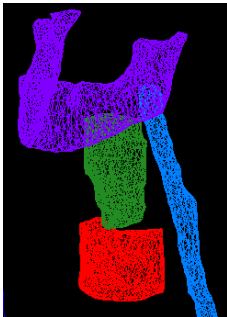


3D Dose-Toxicity Modeling

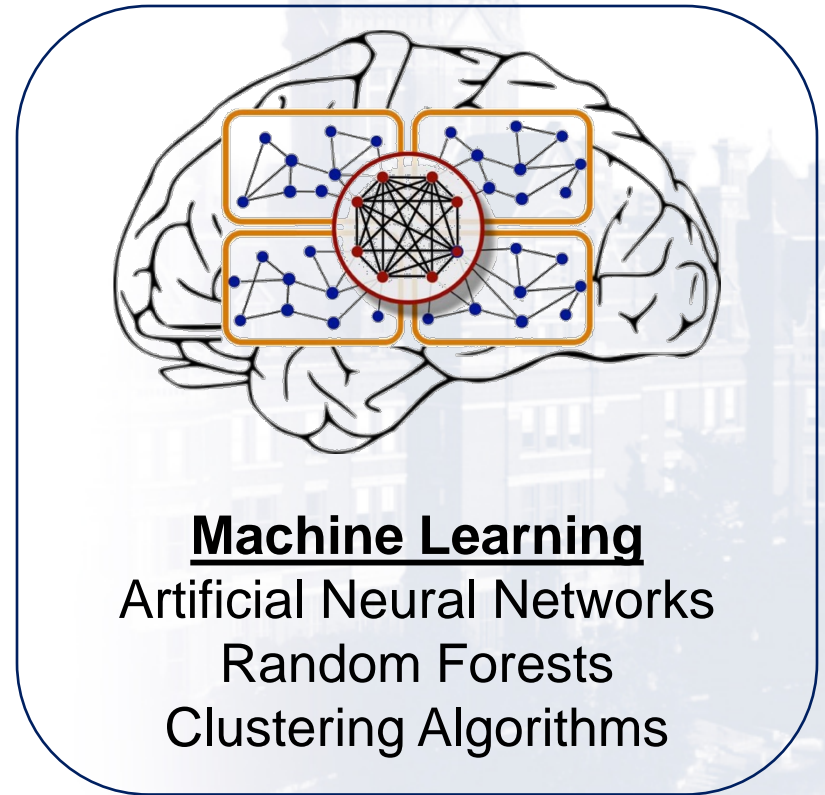
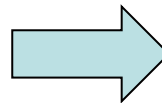
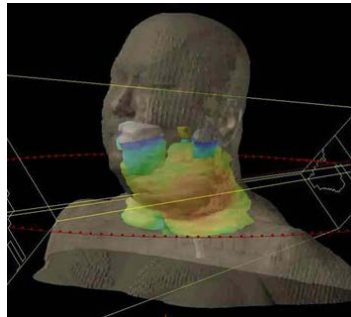
Oncospace



3D Structures



3D Dose



Summary

- Oncospace
 - An informatics platform for next-generation analytics and decision support
 - A goldmine for analysis of normal tissue complications
- Data-Mining
 - Framework supports 2D and 3D dose-toxicity analysis
 - Exploratory studies validate existing knowledge and generate new hypotheses

Thank You!

- Dr. Todd McNutt
- Dr. Harry Quon
- Dr. Ana Kiess
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- Dr. Wuyang Yang
- Dr. Zhi Cheng
- Dr. Andrew Sharabi

