

Radiotherapy UI Seminar Presentation

By: Alaleh Azhir

Partners: Santiago Appiani, William Franceschi
Mentors: Dr. Todd McNutt, Pranav Lakshminarayanan

Project Goal

Develop a **web-based user interface** for refined dose-toxicity analysis:

- Utilize a **Python** built backend to communicate with **SQL database** for obtaining the medically related data
- Create interactive **3D** visualizations of objects using **JavaScript** libraries such as D3.js
- Allow physician to **segment** biological objects into regions, **select** and **drag** regions, and run analysis on new regions
- **Display the results** using interactive histograms (i.e. DVH curves)
- Allow **new** feature analysis scripts to be **easily added** to the existing user interface

Paper Selection

- Our project focuses on providing a way to **visualize radiation therapy data** to assist in its **exploratory analysis**.
- As a background paper, I chose the paper *“How Will Big Data Impact Clinical Decision Making and Precision Medicine in Radiation Therapy?”* to study the **relevance and motivation** for creation of our web-based UI.
- This paper is written by Dr. Chen and our mentor Dr. McNutt.

Background

- Precision medicine refers to **tailoring treatment** to each **individual patient**.
- Precision medicine is increasingly applied in **cancer treatment**, as it has transformed from a **fixed therapy for all patients** solely based on the organ, to a more personalized treatment based on one's **genetic** and molecular factors, leading to better outcomes.
- This personalized treatment however results in **a major issue**:
 - The **decrease** in the number of “**like patients**” treatments impeding our ability to **test research hypotheses** with **sufficient statistical power**.
- **Upside?** **Electronic Health Records** are getting increasingly adopted (an example of “Big Data”) and provide vast data on various patients whose treatments could be similar.

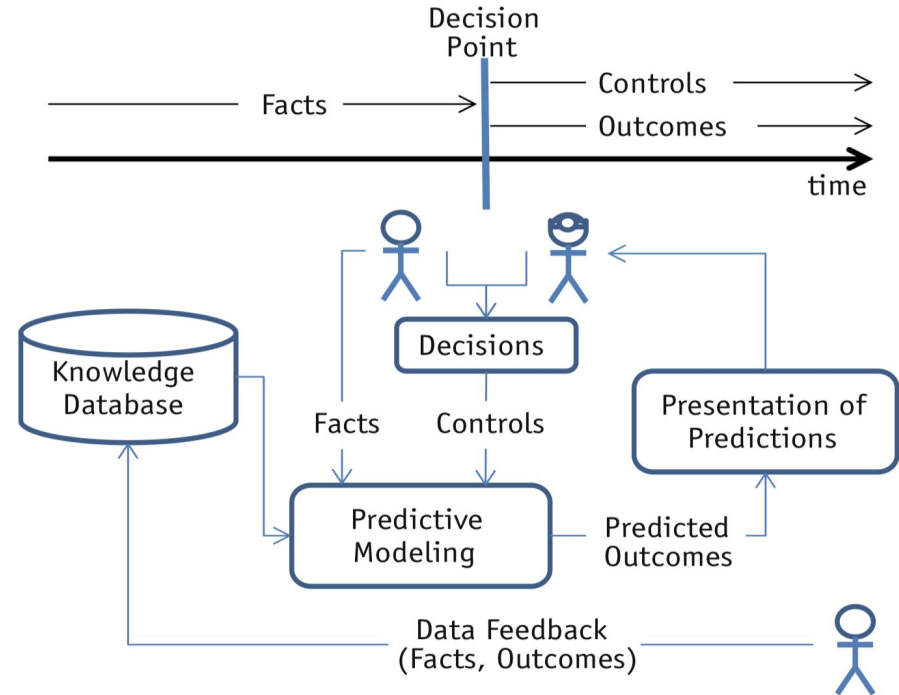
Big Data Use in Clinical Setting

- One use of this data is to **assess current clinical practice** and care quality, studies have shown.
 - **Ex. Underuse of aggressive treatment for high-risk prostate cancer**
 - **Overuse** of bone scans with early prostate cancers: which has led to an over expense of **\$12 million annually** for Medicare
- Another use can be comparative treatments research, big data has a few advantages over clinical trials such as
 - Generalizability, larger sample size, and providing timely results
- **Limitations?** Available big data are about **2-3** years behind the current practice, due to the ever changing nature of the data

Vision for Future

It has been shown that predicting achievable dose based on the organ at risk, and a knowledge database of previous treatments and their outcomes can improve the quality and efficiency of treatment planning.

This data should be retrieved and be open to exploratory analysis at the time of consultation to be relevant in a clinical setting, and each patient's data should be easily incorporated into the database.



Pros

- The vision for future provided our group with a bunch of ideas on what would be useful to integrate into our UI.
- The paper provided an overview of what is the overall goal of our project.
- Through examples in clinical settings, this paper clearly showed the current beneficial uses of big data and its limitations.

Cons

- The authors did not really implement any of their vision for future in the paper, but rather gave examples of current methods.
- This paper does not provide a concrete currently existing UI, for us to build further on, but rather provides an overview of what can be relevant clinically.

Next Steps

- Big data visualization on web:
 - Currently we use D3.js, which accesses Document Object Model elements (i.e if we have 5000 points on the graph, it makes 5000 objects)
 - Consider switching to Pixi.js, which draws onto a canvas (1 element) as one interacts with the object, it updates 1 elements
 - Zooming use tiling methods, by dividing data
- Big data analysis on the web:
 - Include Comparative data Analysis for different patients
 - Currently we process data by passing it to backend Python layer, as our data size grows, this analysis could take longer
 - consider using WebWorkers to stop page from crashing
 - Enable users to make accounts to save progress of their current analysis, through use of gearman or PHP
 - Use Electron.js to transform the code into a desktop application
- Big data storage:
 - Look into compression techniques

Citation

Chen R, Gabriel P, Kavanagh B, McNutt T, “How will big data impact clinical decision making and precision medicine in radiation therapy?” Int’l J. of Radiation Oncology, Biology, Physics. Published online: November 27 2015