

# **A Decision Support System for Prostate Cancer Treatments**

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George Mason University

# Introduction

Prostate Treatment

Decision Support  
System

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- Who are we?
- Agenda
  - Background
  - Problem Statement
  - Database
  - Model
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# Prostate Cancer Background

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- The prostate is a small, walnut-sized structure that makes up part of a man's reproductive system
- Other than skin cancer, prostate cancer is the most common cancer in American men
- About 1 in 6 men will be diagnosed with prostate cancer during his lifetime
- About 1 in 36 men will die of prostate cancer



# Prostate Cancer Diagnosis

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- Unfortunately prostate cancer does not have any early warning signs
- Recommended that men aged 50+ should undergo a yearly digital rectal examination and blood testing for prostatic specific antigen (PSA)
- If diagnosed, the cancer is then staged (I-IV) to describe the cancer's spread

# Choosing a Treatment

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- Prostate cancer is unique in that it is a slow moving disease - variety of treatment options
- There are many factors that are involved in a treatment decision
  - Patient Profile: stage of prostate cancer, health, etc
  - Patient Preferences on treatment criteria: recovery time, cost, etc.
- Patient's may receive misguided advice
  - Doctor: Biased towards their specialty
  - Friends & Family: Based on misconceptions and anecdotal experiences

# Project Overview

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- **PROBLEM STATEMENT:** Prostate cancer patients want to be better informed when making decisions about treatment
- **OBJECTIVE:** Build a Decision Support System (DSS) to help a prostate cancer patient make an informed decision
  - Elicits patient preferences on side effects and lifestyle impacts
  - Gathers patient data input (Gleason Score, PSA, Age)
  - Generates a patient profile to assist with a decision

# Where To Start?

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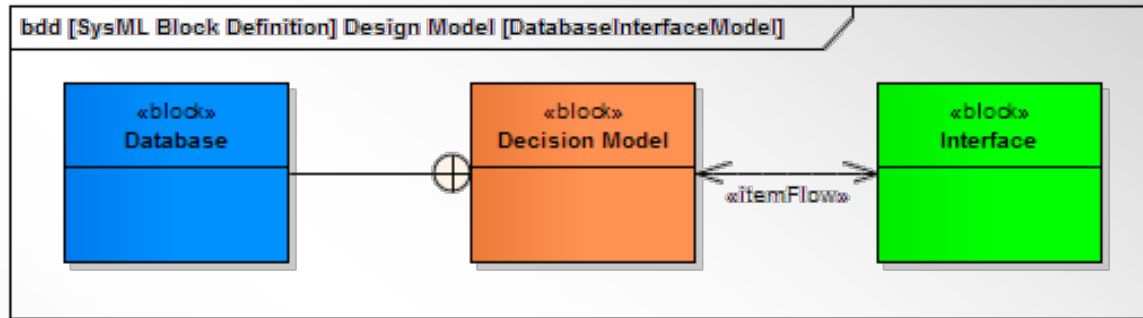
Database

Value Model

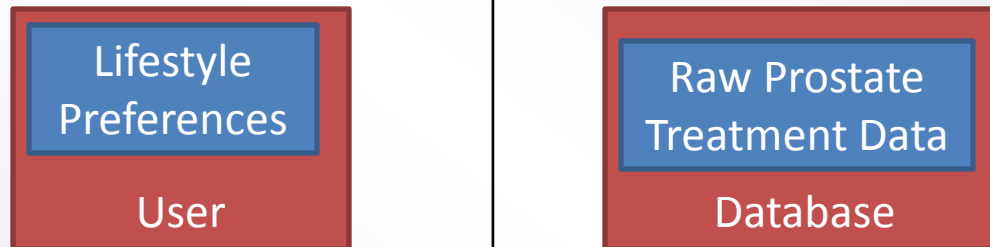
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What we have



Value Model

Need to design

Rank of Treatments

End Result

# Database

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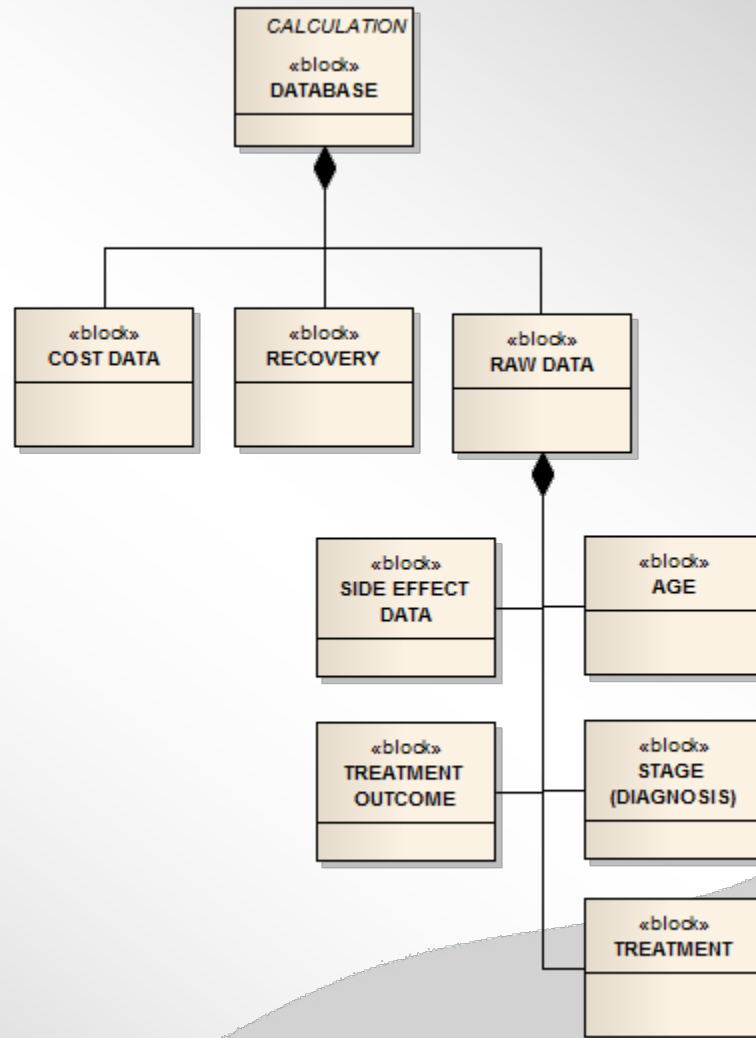
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# Self-Reported Database

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- Over 1,000 lines of self-reported patient data
  - GS, PSA, Age, Stage,
  - Treatment,
  - Side Effects
- Received data from sponsor
  - Unknown source
- Data Cleanup
  - Handle misspellings
  - Remove ambiguous / nonsense inputs

	"Lost no ""manhood points"" "
1.75	Re-seed:ED/urinary

# Data Analysis

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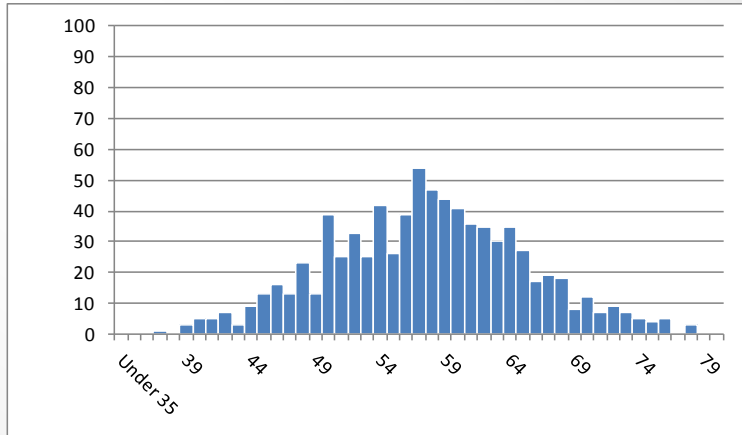
Value Model

User Interface

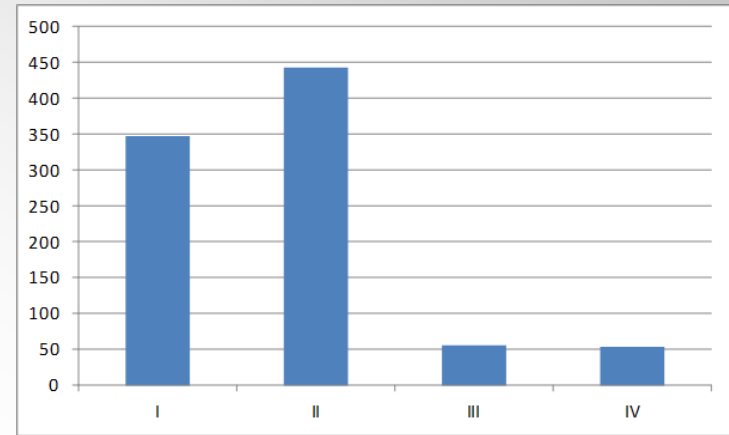
Prototype

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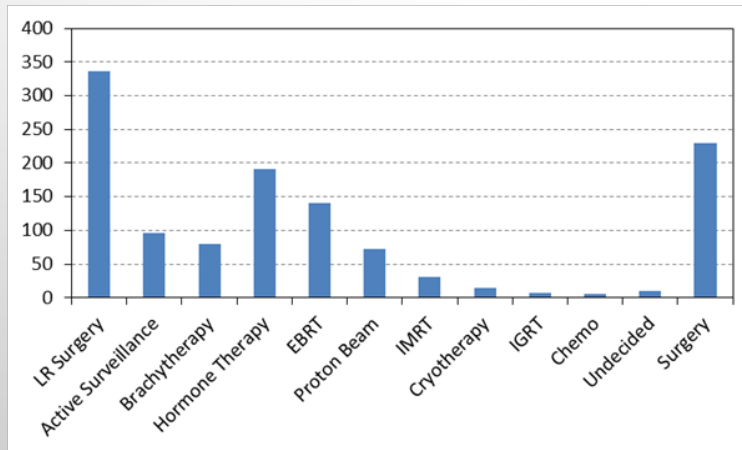
### Age



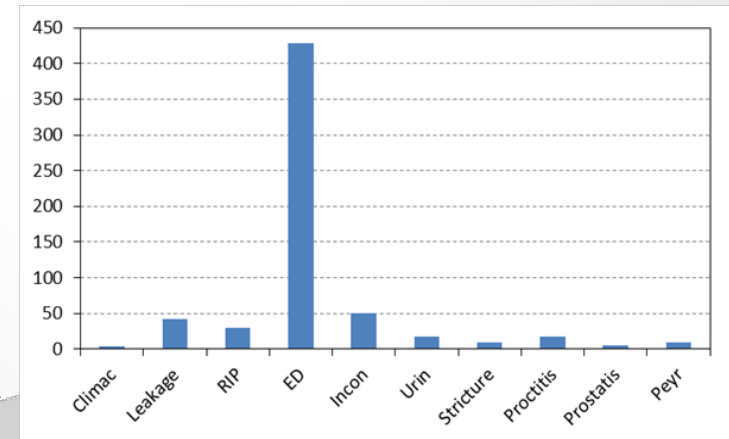
### Stage



### Treatments



### Side Effects



# Data Grouping

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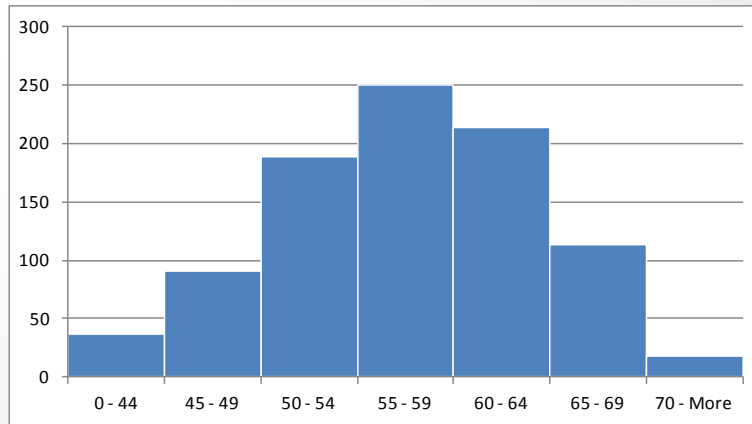
Value Model

User Interface

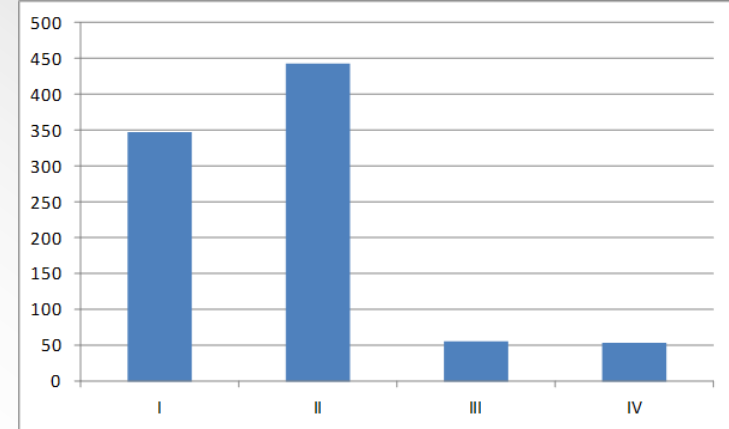
Prototype

Conclusion

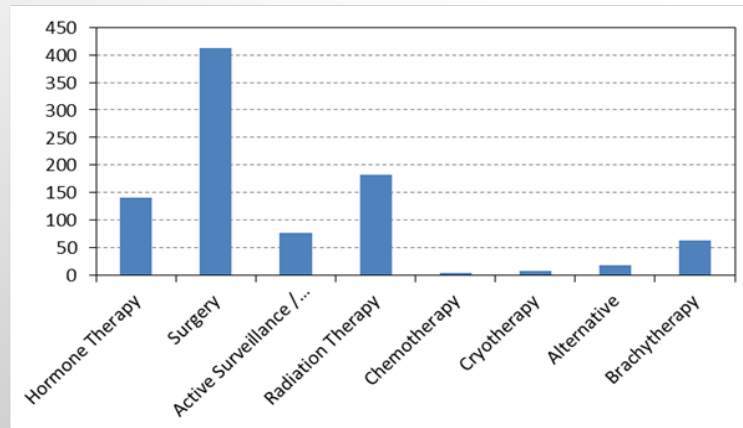
### Age



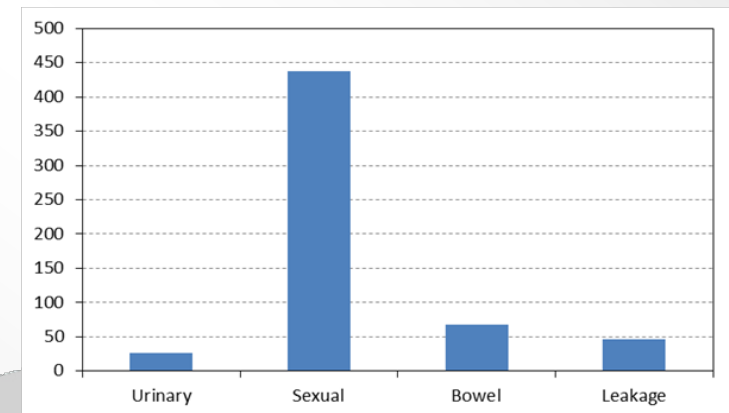
### Stage



### Treatments



### Side Effects



# Researched Data

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- **Cost**
  - Depends on patient
    - Insurance coverage
    - Location
  - Varies from source to source
  - Decided to remove cost from DSS
    - Present in Pareto chart in the output
- **Recovery Time**
  - Time it takes patient to return to work
- **Additional Side Effects**
  - Raw data did not include all treatment side effects
  - Added physical illness, change in appearance, and infertility

# Data Overview

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- Summary
  - Reduced 1,046 to 803 data points after cleanup
  - 7 Age Groups
  - 8 Treatments
  - 7 Side Effects
- Data Tables
  - # of data points with responses
  - # of occurrences of side effect
  - Average PSA before treatment
  - Average PSA after treatment

# Decision Model

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- Problem Breakdown
- Build a composite Value Architecture
  - Additive Model
  - Constraining Factors

# Problem Breakdown

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<b>Actors (A)</b>	<b>Objects (O) aka stakes</b>	<b>Resources (S)</b>
<b>Patient</b>	Cancer Reduction	Medical Equipment
<b>Doctors</b>	Minimize Side Effects	Medical Supplies
<b>Nurses</b>	Minimize Cost	Doctor Skills
<b>Family Members</b>	Minimize Time of Treatment	Funding, Monetary Sources
<b>Insurance Agents</b>	Minimize Time of Recovery	





# Value Architecture (Model)

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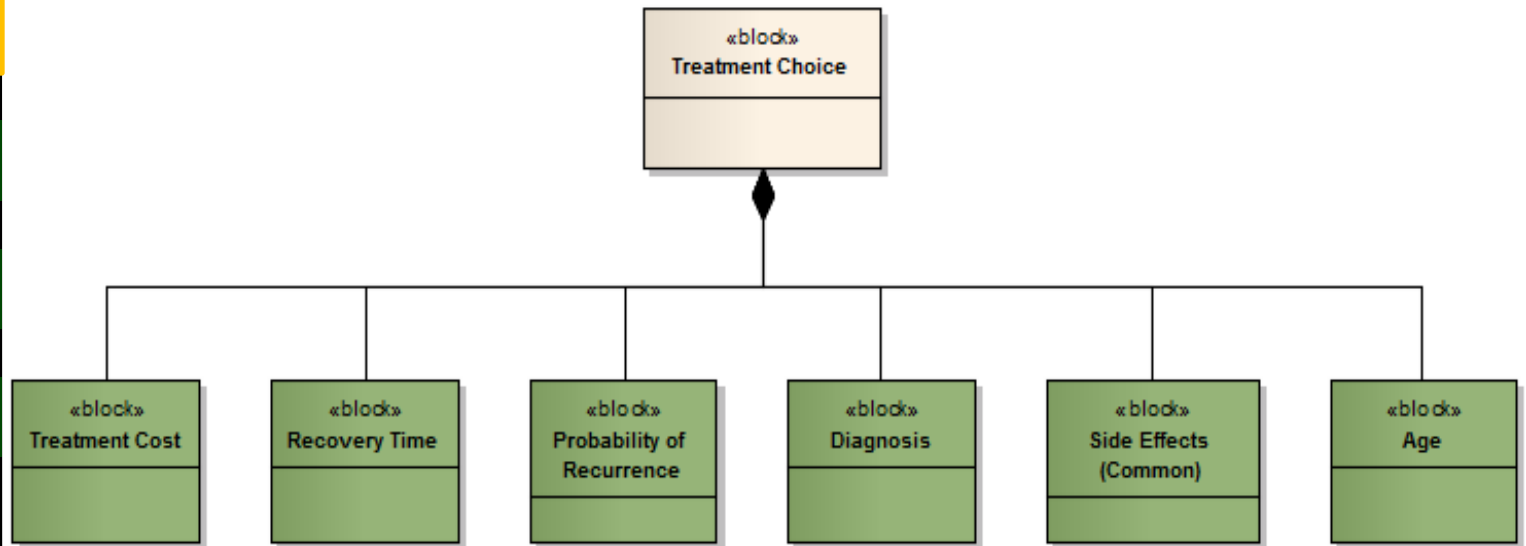
**Value Model**

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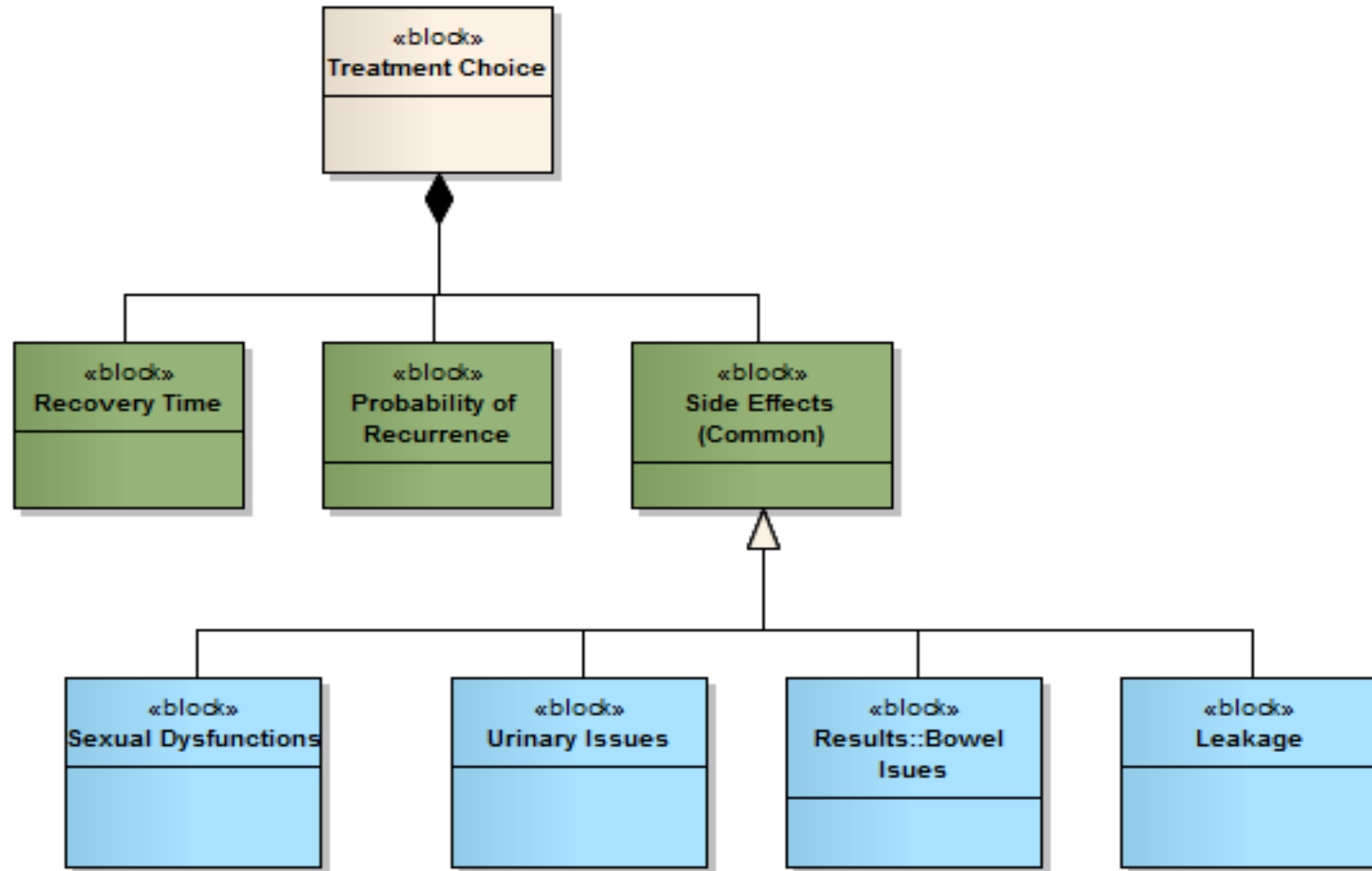
Conclusion

- Starts with problem analysis:  
Actors, Objects, Resources
- Derived a composite value model



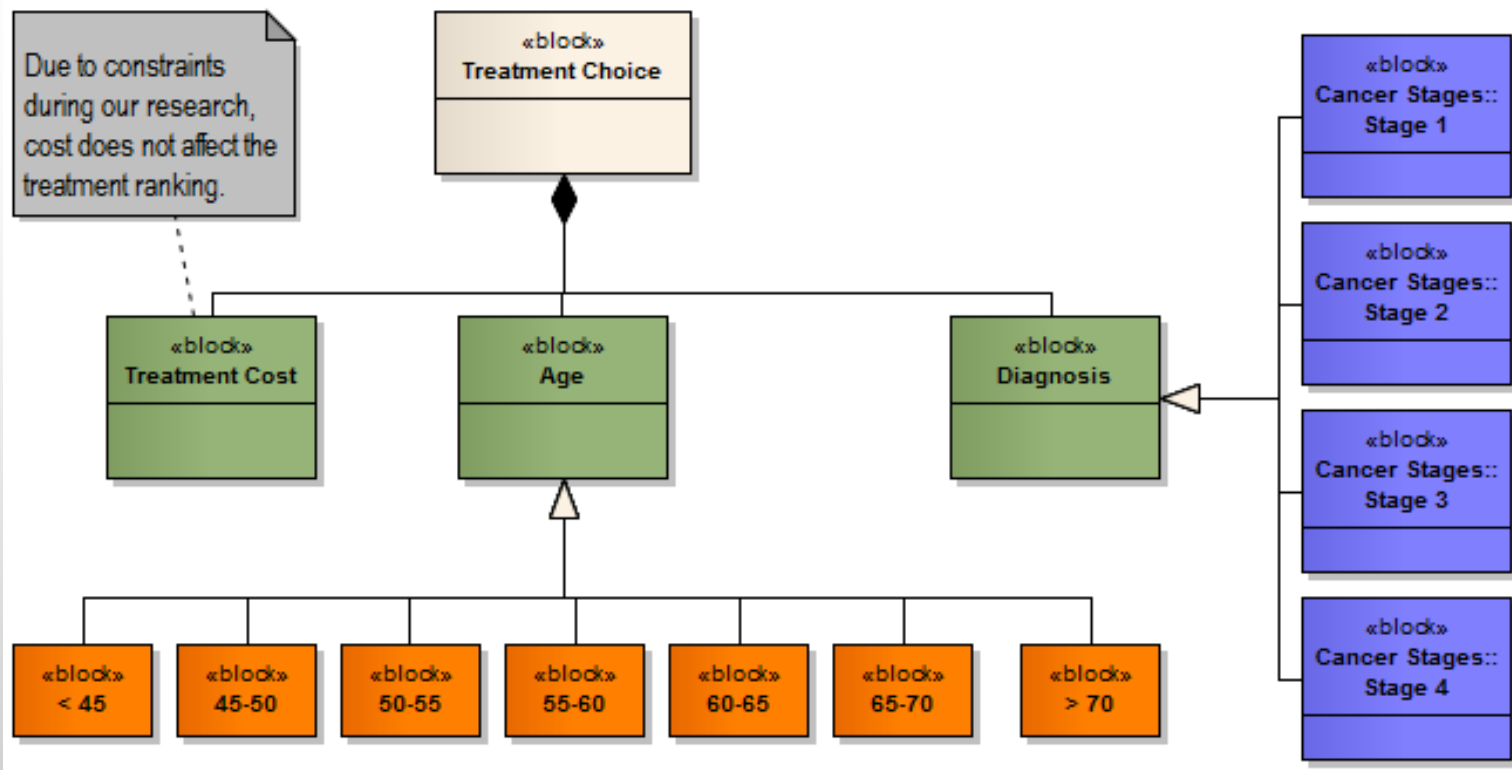
# Additive Model

- Requires two separate elicitations



# Constraining Factors

- Two factors change the sensitivity analysis for certain alternatives



# Elicitation Objectives

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- Side Effect Preferences
  - Sexual Dysfunction
  - Leakage
  - Urinary Issues
  - Bowel Issues
  - Physical Illness
  - Infertility
  - Change in Appearance
- Lifestyle Preferences
  - Prostate Cancer Recurrence
  - Recovery Time
  - Side Effects
- Assumption
  - The worst case of the above is better than having prostate cancer

# Elicitation Method

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- Present worst case for all attributes
- Inquire which attribute to improve to the best case
- User ranks their preferences, ties allowed
- Rank Reciprocal used to weight preferences
- Graphically presented relative weights and gave user opportunity to change
- Simplest method for non-interactive elicitation

# Output

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- Patient Summary
  - Age Group and Stage (Profile)
  - Most/Least Important Attribute
  - The number of data points in the database that matched their profile
- Pareto Frontier
  - Plotted Treatment Utility vs. Cost
- Treatment Ranking
  - Most/least cost effective treatment
  - Most/least preferable treatment based on user's most important lifestyle attribute
  - Rank of treatments based on overall utility

# Output: Pareto Frontier

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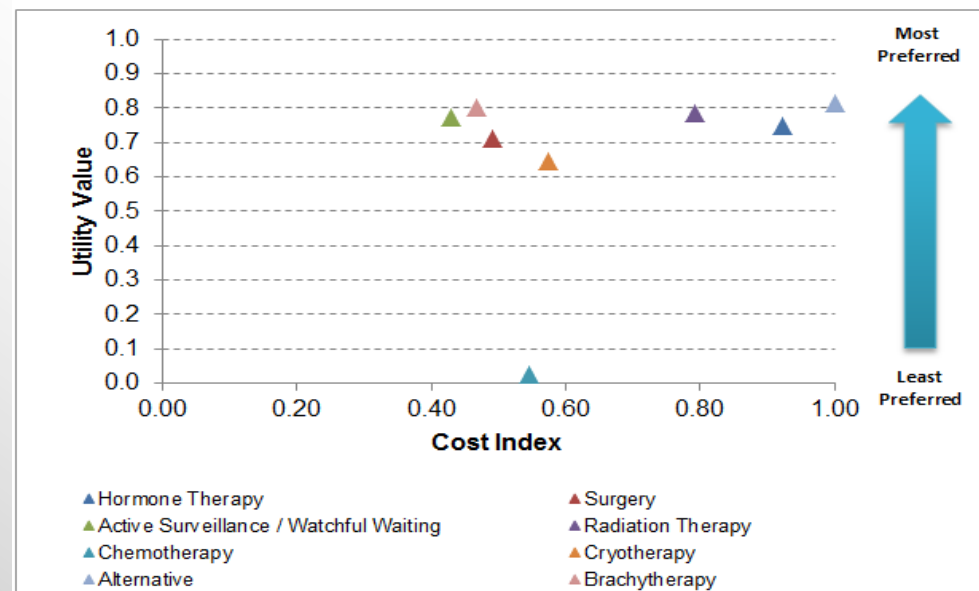
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- Patient's usually don't know the specifics of their insurance coverage → can't determine how much treatments will cost
- Doctors only care about patient being able to cover the cost of the treatment



# Output: Treatment Ranking

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- Show a preferential ranking based on overall utility
- For use as a discussion tool between a patient and a doctor

Rank	Treatment	Description
1	Alternative	Non-invasive treatment - high energy focused ultrasound beam is concentrated on the prostate gland to warm and terminate the prostate cancer.
2	Brachytherapy	Insertion of radioactive seeds into the prostate gland.
3	Radiation Therapy	Uses high levels of radiation to kill prostate cancer cells or keep them from growing and dividing.
4	Active Surveillance / Watchful Waiting	You and your doctor closely monitor your prostate cancer for any changes. No medical treatment is provided.



# Prototype

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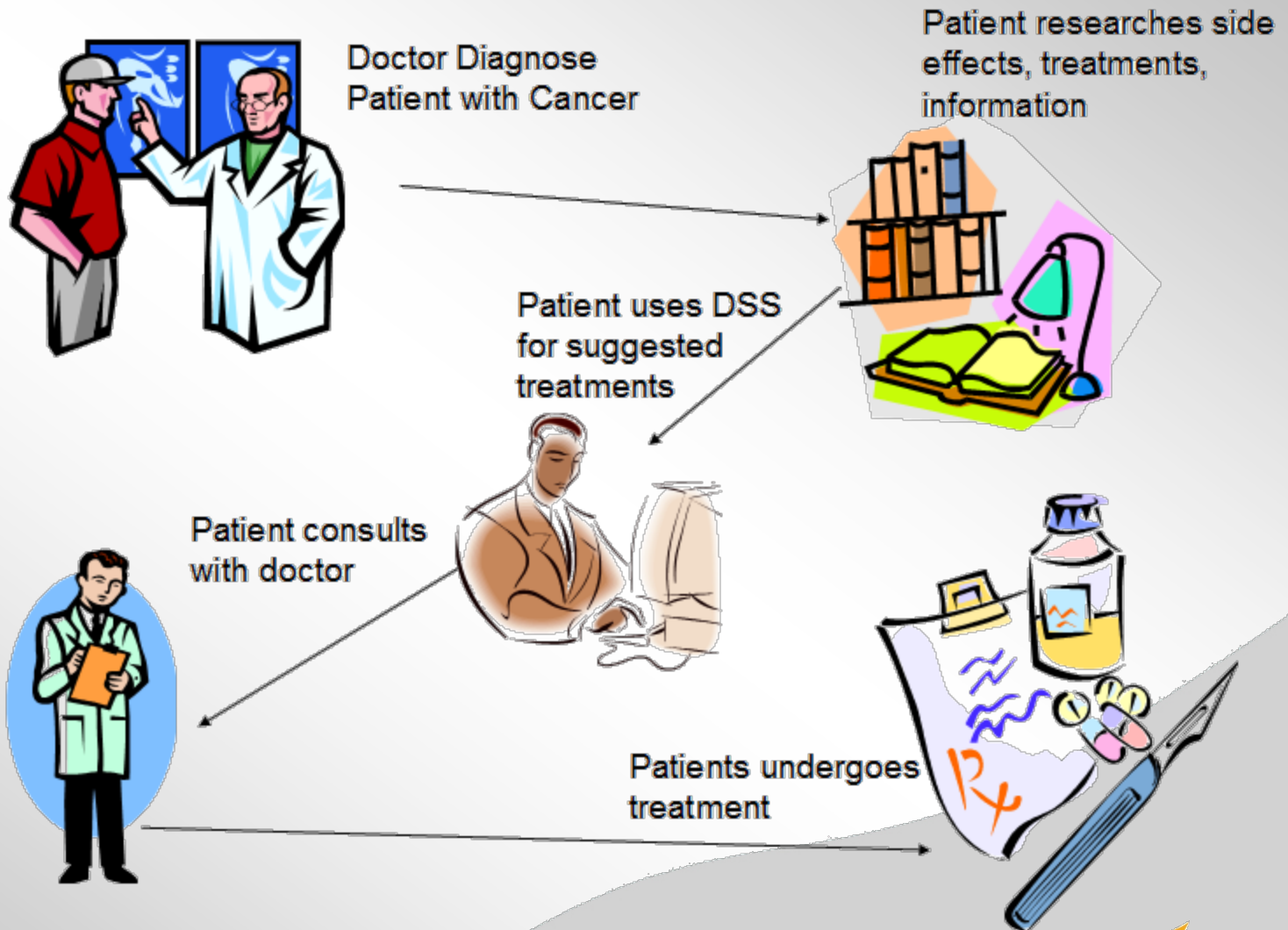
Database

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# Prototype: Walkthrough

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← Prev Step      **USER PROFILE**      Next Step →

NAME: LAST	<input type="text"/>	FIRST	<input type="text"/>
AGE*	<input type="text"/>		
ADDRESS	<input type="text"/>	CITY	<input type="text"/>
STATE	<input type="text"/>	ZIPCODE	<input type="text"/>
USERNAME	<input type="text"/>		
PASSWORD	<input type="text"/>	RETYPE PASSWORD	<input type="text"/>
EMAIL	<input type="text"/>	REYPE EMAIL	<input type="text"/>

\* Required field

← Prev Step      **HEALTH PROFILE**      Next Step →

**PART 1**

**Question 1**  
*How often do you drink alcohol?* glasses per week

**Question 2**  
*How often do you smoke?* cigarettes per day

**Question 3**  
*How often do you exercise?* times per week

**Question 4**  
*Do you have any prior heart conditions?*

# Prototype: Walkthrough

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## PART 2

*If you already know your stage of cancer, please skip to Question 4. Otherwise, please fill out questions 1-3 and we will estimate your stage of cancer.*

### Question 1

*What is your PSA Score?*

### Question 2

*What is your Gleason Score?*

### Question 3

*What is your TNM Staging? (If you do not know this then proceed to the next step)*

T-category

N-category

M-category

[Click here for more information on TNM](#)

### Question 4

*What is your Stage of Cancer?*

# Prototype: Walkthrough

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For the ranking, select each cell, then choose from the dropdown boxes:

Most Like to Improve

Indifferent

1 Sexual Dysfunction  1 & 2 Are Tied

2 Bowel Issues  2 & 3 Are Tied

3 Change in Appearance  3 & 4 Are Tied

4 Physical Illness  4 & 5 Are Tied

5 Leakage  5 & 6 Are Tied

6 Urinary Issues  6 & 7 Are Tied

7 Infertility

Results:

Attribute	Weight
Sexual Dysfunction	0.25
Bowel Issues	0.25
Change in Appearance	0.15
Physical Illness	0.15
Leakage	0.10
Urinary Issues	0.08
Infertility	0.05

If you would like to adjust anything, do so now. For each attribute, you may adjust it up or down, and see the results in the chart below

▲ ▼	Sexual Dysfunction	0
▲ ▼	Bowel Issues	0
▲ ▼	Change in Appearance	0
▲ ▼	Physical Illness	0
▲ ▼	Leakage	0
▲ ▼	Urinary Issues	0
▲ ▼	Infertility	0

Note, these number are so you can tell how much you've adjusted them relative to each other; they do not represent the measured adjustment for each. The weights of the factors add to 1.

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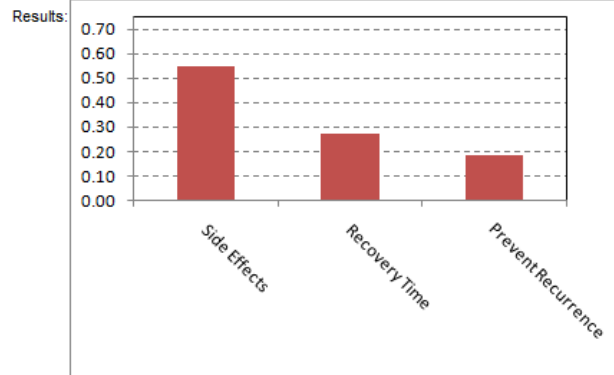
← Prev Step
TIER 1 QUESTIONNAIRE
Next Step →

Rank the following [attributes] in order of importance, from most important to least important. Ties are allowed.

<b>Side Effects</b>	Side effects from the treatments. Include sexual dysfunction, urinary issues, leakage, and bowel issues.
<b>Recovery Time</b>	Time it takes to return to normal activities after treatment.
<b>Prevent Recurrence</b>	Prevent the cancer from reoccurring in the prostate/spreading to other organs. This is a probability, ranging from 0% chance of recurrence to 100% chance of recurrence.

For the ranking, select each cell, then choose from the dropdown boxes:

Most Important 1 Side Effects  1 & 2 Are Tied  
↓  
 Least Important 2 Recovery Time  2 & 3 Are Tied  
3 Prevent Recurrence



If you would like to adjust anything, do so now. For each attribute, you may adjust it up or down, and see the results in the chart below

▲		0
▼	Side Effects	
▲		0
▼	Recovery Time	
▲		0
▼	Prevent Recurrence	

*Note, these numbers are so you can tell how much you've adjusted them relative to each other; they do not represent the measured adjustment for each. The weights of the factors add to 1.*

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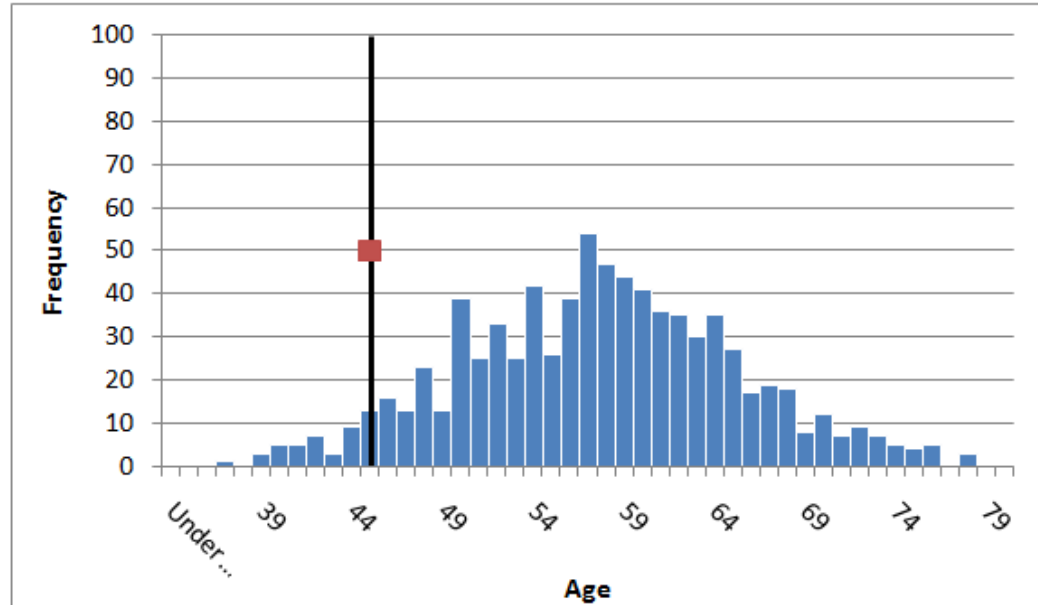
## HEALTH PROFILE

### Patient Summary

Age Group:	45 - 49
Stage of Prostate Cancer:	Stage 2
Most Important Attribute:	Side Effects
Least Important Attribute:	Prevent Recurrence

### Where do you fall in the data set?

Total # of data pts that match your age and stage of cancer:	0
Total # of data pts in the data set (all ages & stages):	803



# Sensitivity Analysis

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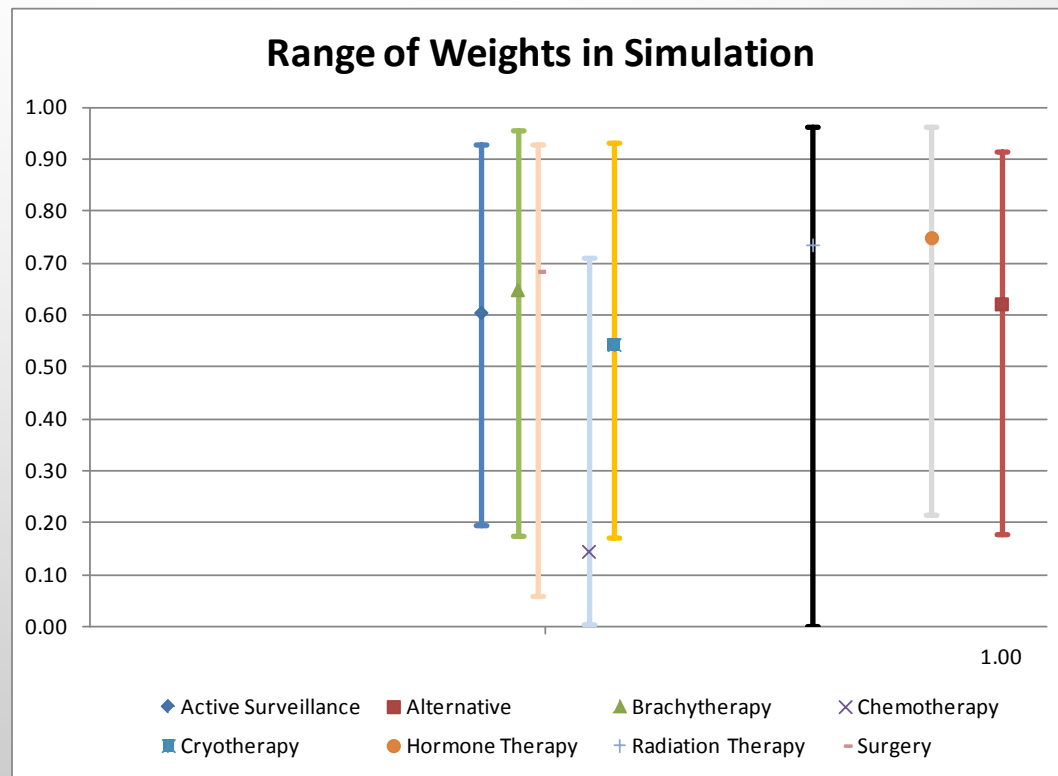
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- Crystal Ball performed Monte Carlo
  - Simulation tool that enters random values for inputs based on assigned distributions
- Utility range for each treatment



# User Feedback

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- Received feedback from 3 users
- Doctor never told the user their stage of prostate cancer
  - Calculate the user's stage based off their PSA level, Gleason Score, and TNM stage
- User did not know any information about the side effects (what strictures is)
  - An information tab was added to explain all medical terms/conditions to the user



# User Feedback Cont

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- User did not feel the model was complete. Was aware of side effects not listed in the model
  - Researched additional side effects such as hair loss, weight gain/loss of muscle, infertility, hot flashes, nausea, and fatigue
- Quality of Adjusted Life Years (QALY), a proven medical elicitation method, was too difficult to score
  - Simplified elicitation method to ranking attributes and graphical analysis
- Pointed out broken links, missing drop boxes, unclear questions

# Summary/ Recap

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- We presented a model and prototype decision support system for determination of a prostate cancer treatment
- The system is an informative tool
- It incorporates a patient's preferences concerning side effects and other factors into the resulting rank of treatments
- The resulting rank can then become a point of conversation with the patient's doctor

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# QUESTIONS?

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# BACKUP

# Acknowledgements

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- THANKS

# Lessons Learned

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**Conclusion**

- Prostate cancer treatment is a complex decision
- Peer review helps spot unclear and confusing survey questions
- Ensure peers understand assumptions
- Excel powerful tool
- Rank method is easiest to understand for program user

# Future Work

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- Add more prostate cancer data to the database.
  - Current database was reduced to 803 entries after the initial data cleanup
  - Reduced further once the data was filtered on the patient's health profile.
  - Improve the results by providing more representative measures for the treatment criteria (probability of recurrence, probability of side effect, etc).
- Additional information may provide data behind side effects that were not reported in the current database (e.g. fatigue, muscle loss, infertility).
- Testing/Validation process with a large set of patients.
  - more users with varying backgrounds will be important in determining the effectiveness of the model.
- The database will eventually need to be moved to Access or another program because of the data constraints in Excel

# Requirements

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## Sample of Requirements for the prototype

1. Stakeholders Requirements:
  - 1.1. The system shall provide an interface to view results
  - 1.2. The system shall provide a means of inputting customer preferences.
  - 1.3. The system shall provide an electronic file with customer's information.
  - 1.4. The system shall provide a means of navigating through the program.
  - 1.5. The system shall operate with window XP, Vista, and 7
  - 1.6. The system shall operate in excel 2007 and 2010
  - 1.7. The system shall be useable by December 1<sup>st</sup>
  - 1.8. The system shall store patient's information securely
  - 1.9. The system shall allow data to be expandable
    - 1.9.1. The system shall be able to auto update statistics with future raw data
  - 1.10. The system shall provide tech support
  - 1.11. The system shall provide a means of debugging the system



# Prototype: Sequence

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- Sequence from one step to the next
- Lifelines are Patient, Interface, Database, Calculations
- Starts at Patient reading Welcome Screen
- Ends on interface displaying the results
- Remainder of diagrams can be viewed in report

