Detecting Prostate Cancer Using MRI Data

David Anderson, Bruce Golden, Ed Wasil, Howard Zhang

INFORMS Annual Meeting October, 2013

1

Prostate Cancer

- The NCI estimates that 15% of men born today will be diagnosed with prostate cancer

- Average costs of $10,000 in the first year after diagnosis

- Hard to diagnose

Prostate Cancer Diagnosis Methods

- PSA Test
  - Non-intrusive
  - High false positive rate
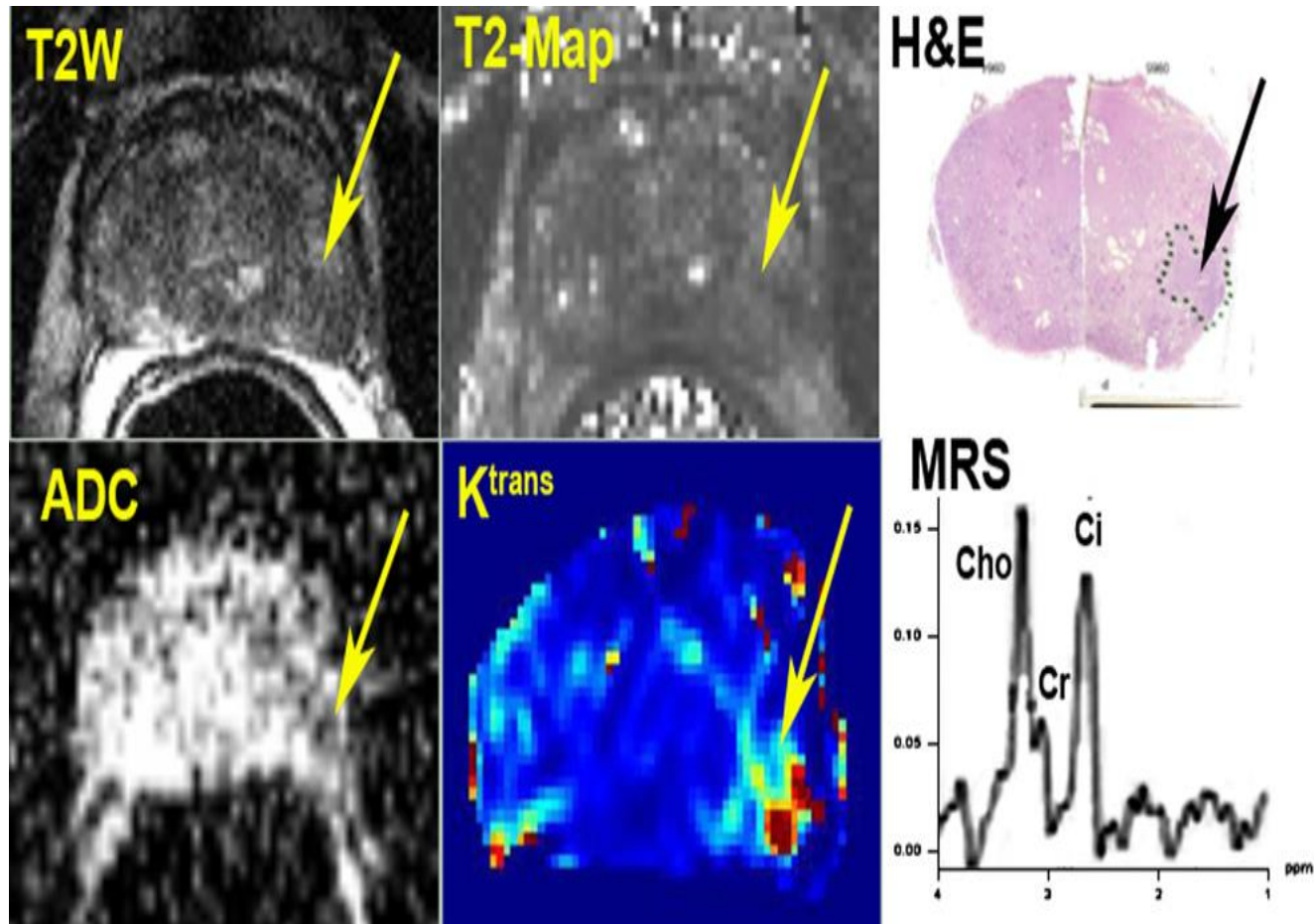   - 67% sensitivity, 58% specificity (Thompson et al. 2005)
- Digital Exam
  - Inconsistent
- Biopsy
  - Painful
  - Expensive
  - Possibly severe side effects

MRIs to the Rescue?

Research Question

- Can we use MRIs to screen for prostate cancer?

  ◦ Will doing so be more cost effective than the current system?

# Data

- 223 slices of prostates from radical prostatectomy patients

- 3 types of MRIs on each slice (Dynamic Contrast Enhanced, Diffusion Weighted, and Magnetic Resonance Spectroscopic Imaging)

- 119 had cancer (Gleason score of 5 or above)

Independence of Slices

- Slices from the same prostate may have similar cancer status and MRI data
- Correlation between slices of the same prostate would bias our performance upwards
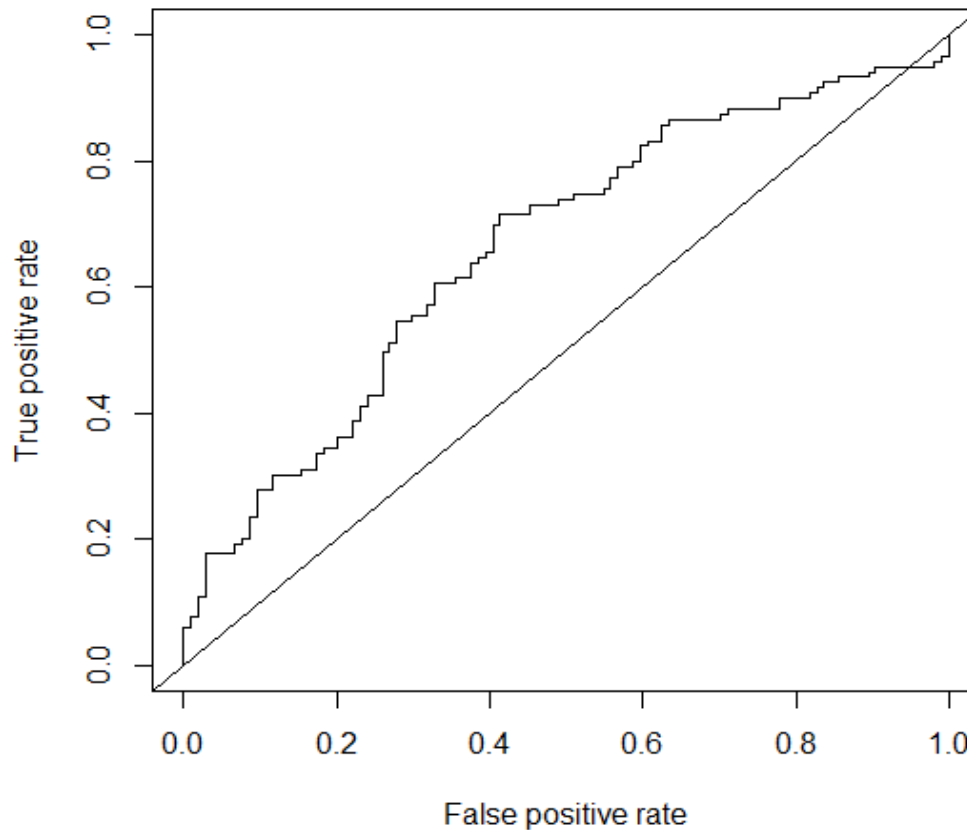- Correlation in Gleason scores of adjacent slices is 0.30, and for slices two apart it is 0.004
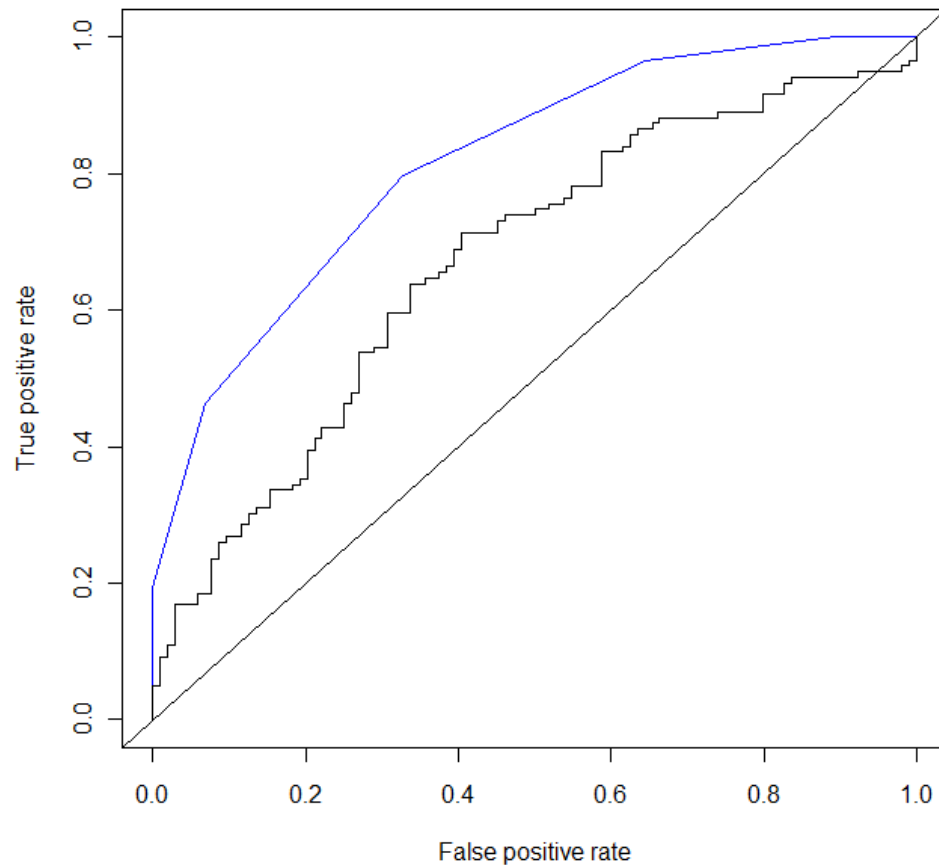
Distribution of Cancer

Historgram of Gleason Scores
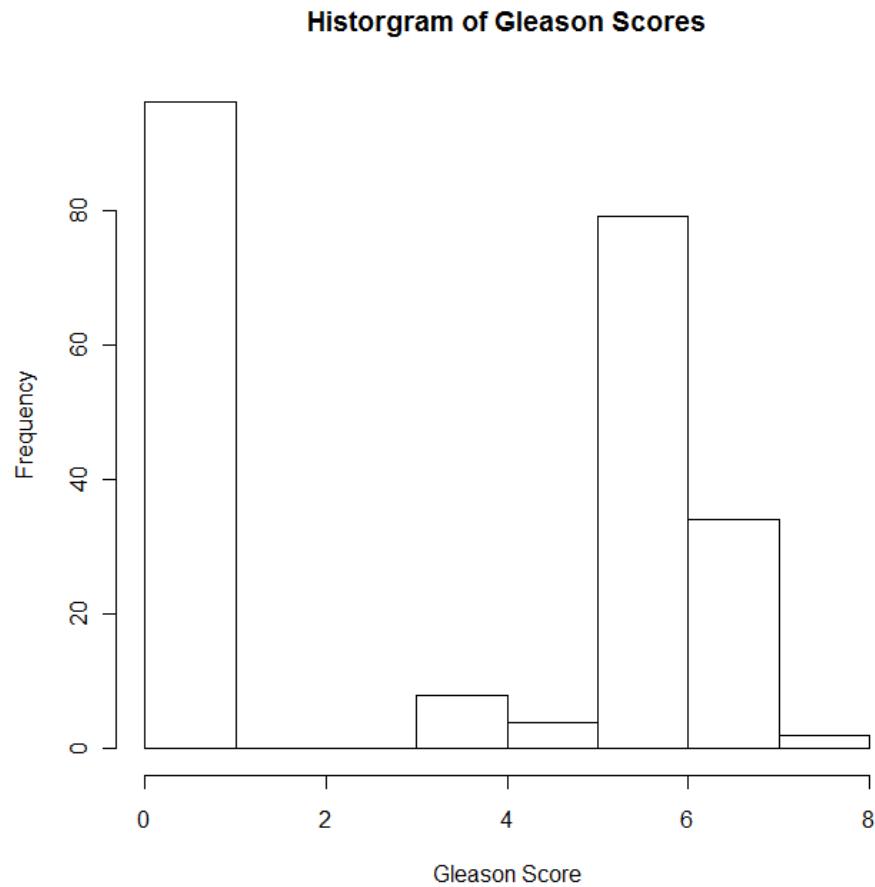
Three Methods

▸ Logistic Regression

▸ Nearest Neighbors Clustering

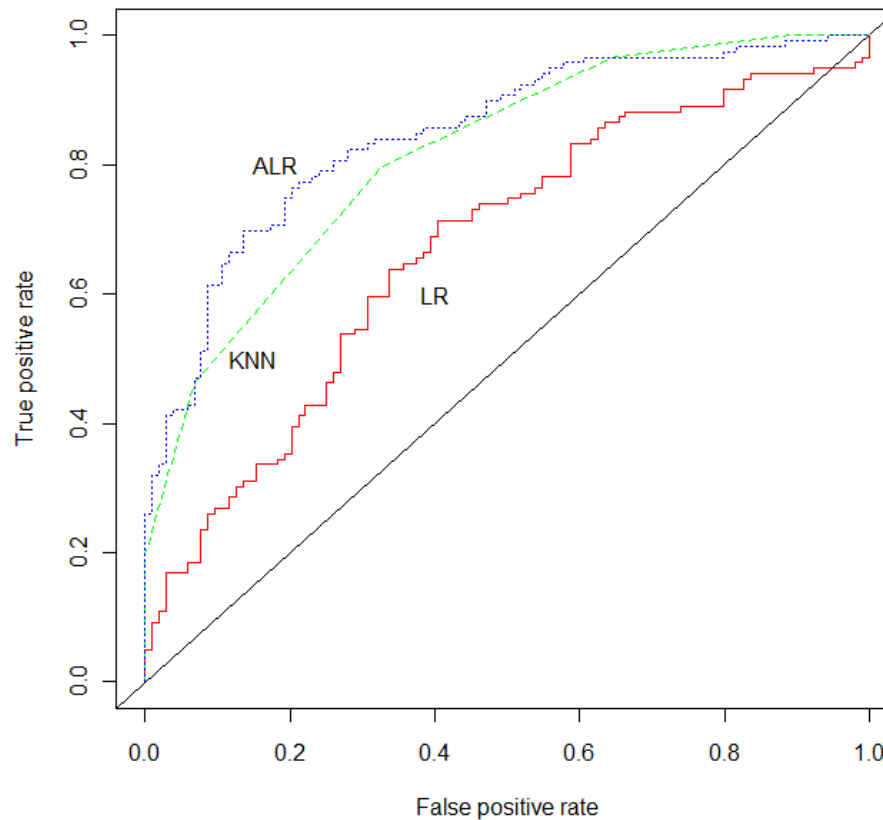▸ Augmented Logistic Regression

Results – Logistic Regression

Results – Nearest Neighbors

Augmented Logistic Regression Results

Augmented Logistic Regression Results

	Gleason Score	
	0 – 4	5 – 8
Predicted Healthy	79	22
Predicted Cancer	25	97

The combined model achieves 82% sensitivity and 76% specificity

High Severity Cancer

- Many prostate cancers are slow growing
  - "More men die 'with' prostate cancer than 'from' it"

- Identifying high severity cancer (scores of 7 or 8) is important

High Severity Results
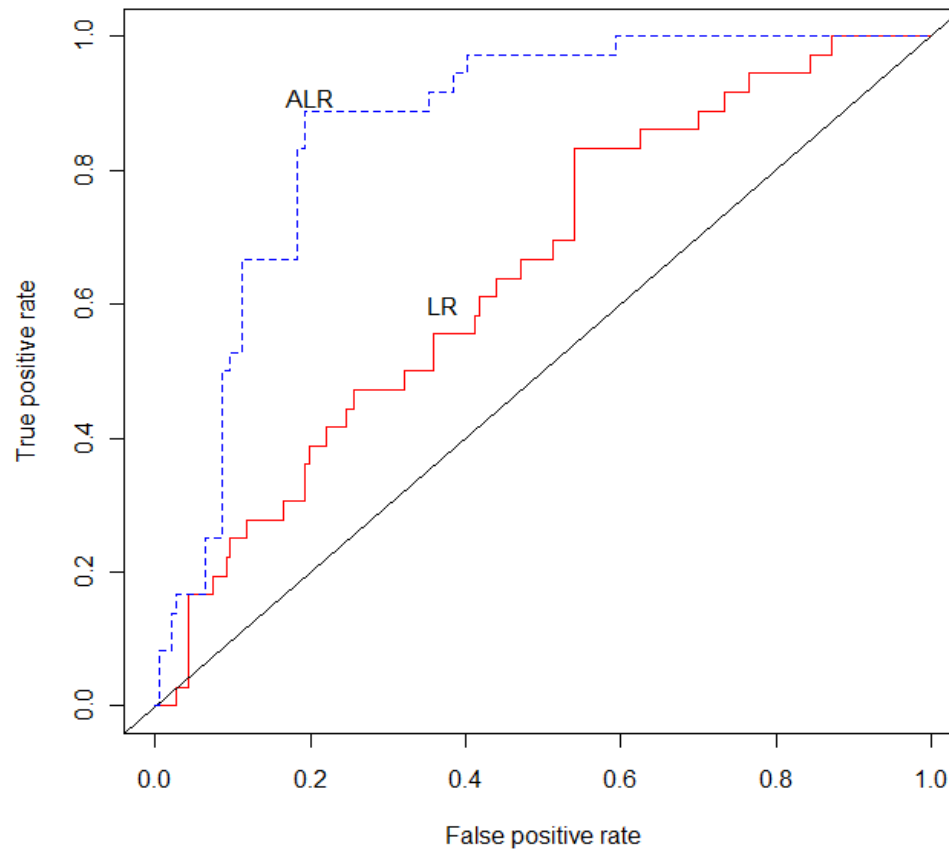
High Severity Results

	Gleason Score	
	0 – 6	7 – 8
Predicted Healthy	151	5
Predicted Cancer	36	31

For high severity cancers, the combined model achieves 81% sensitivity and 86% specificity

Cost Effectiveness

▸ Prices for medical services vary widely
  ◦ Biopsies average ~$2100
  ◦ MRIs average ~$700

▸ If MRIs can reduce the number of biopsies by at least 1/3 they will reduce costs

Conclusions

- MRIs can be used to identify prostate cancer

- By looking at each slice of a prostate we can identify where to biopsy

- MRIs offer possibly better predictive power than PSA tests, and are less invasive than biopsies

Contribution

▸ Combine MRI types

▸ Automated prediction

▸ Distinguish between high and medium severity cancers

Future Work

- Collect more data
  - Healthy patients and cancerous

- Build models for whole prostates, not slices

- Predict specific Gleason scores

Questions?

David.Anderson@Baruch.CUNY.edu