Detecting Prostate Cancer Using MRI Data

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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
- Digital Exam
  - Inconsistent
- Biopsy
  - Painful
  - Expensive
  - Possibly severe side-effects
MRIs to the Rescue?
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 $\geq 5$)
Distribution of Cancer

Histogram of Gleason Scores

Gleason Score

Frequency

0  20  40  60  80

0  2  4  6  8
Three Methods

- Logistic Regression
- Nearest Neighbors Clustering
- Augmented Logistic Regression
Results – Logistic Regression

![Graph showing the relationship between true positive rate and false positive rate.](image-url)
Results – Nearest Neighbors

![ROC curve for Nearest Neighbors](image)

- True positive rate vs. False positive rate

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Note: The image shows a ROC curve for Nearest Neighbors, with the true positive rate plotted against the false positive rate.
Combined Results
Combined Results

<table>
<thead>
<tr>
<th></th>
<th>Gleason Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 – 4</td>
</tr>
<tr>
<td>Predicted Healthy</td>
<td>79</td>
</tr>
<tr>
<td>Predicted Cancer</td>
<td>25</td>
</tr>
</tbody>
</table>

The combined model achieves 82% sensitivity and 76% specificity.
Many prostate cancers are slow growing
  ◦ “More people die ‘with’ prostate cancer than ‘from’ it”

Identifying high severity cancers is important
High Severity Results
## High Severity Results

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<tr>
<th>Gleason Score</th>
<th>Predicted Healthy</th>
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<tr>
<td>0 – 6</td>
<td>151</td>
<td>36</td>
</tr>
<tr>
<td>7 – 8</td>
<td>5</td>
<td>31</td>
</tr>
</tbody>
</table>

For high severity cancers, the 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 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?

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