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
    - 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

Histogram 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

<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>
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</tbody>
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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

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

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