Predicting Surgery Duration w. Neural Heteroscedastic Regression

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https://arxiv.org/abs/1702.05386
Predicting Surgery Duration

- Surgeries are expensive, partly due to cost of facilities
- More efficient use of operating rooms can lower costs
- Current scheduling: book avg. duration for that procedure
  - Neglects patient, doctor, and facility-specific details
  - Neglects conditional variance
Regression (Minimize Error)

\[
\min \sum_{i} (\hat{y}(x_i) - y_i)^2
\]
Regression (Probabilistic)

\[
\min_{\theta} \sum_i - \log p(y_i | \hat{y}(x_i))
\]
for constant variance:

\[
\min_{\theta} \sum_i (\hat{y}_i - y_i)^2
\]
Two Problems

• In reality, variance is not constant

  1. The amount of variance depends on the patient, doctor, anesthesia, facility, and procedure

• The Gaussian is a preposterous likelihood function

  2. Surgeries cannot take negative duration
Heteroscedasticity
Heteroscedastic Regression

\[ \hat{\mu}_i \]

\[ \hat{\sigma}_i \]
Predicted Deviation Scales with Actual Error
## Results

<table>
<thead>
<tr>
<th>Models</th>
<th>RMSE</th>
<th>MAE</th>
<th>NLL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Method</td>
<td>49.80</td>
<td>28.87</td>
<td>1.2385</td>
</tr>
<tr>
<td>Procedure Means</td>
<td>49.06</td>
<td>27.70</td>
<td>1.2222</td>
</tr>
<tr>
<td>Linear Regression</td>
<td>45.23</td>
<td>25.07</td>
<td>1.1446</td>
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<tr>
<td>MLP Gaussian</td>
<td>43.51</td>
<td>23.90</td>
<td>1.1102</td>
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<tr>
<td>MLP Gaussian HS</td>
<td>44.03</td>
<td>24.23</td>
<td>0.7325</td>
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<tr>
<td>MLP Laplace</td>
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<tr>
<td>MLP Gamma HS</td>
<td><strong>43.38</strong></td>
<td>23.23</td>
<td><strong>0.4668</strong></td>
</tr>
</tbody>
</table>

Table 1: Performance on test-set data (lower is better). MLP models outperform alternatives at the 1% significance level or better.
Thanks & Visit Our Poster

- Learn about economic tradeoffs (how to use this!)
- Qualitative analysis (what models tell us!)
- Recruit Nathan (Graduating next year!)

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