Predicting Elective Surgery Duration

Zahra Shahabi Kargar a,b, Sankalp Khanna a,b, Norm Good a, Abdul Sattar b, James Lind c, John O’Dwyer a, Justin Boyle a, Rajiv Jayasena a

a The CSIRO Australian e-Health Research Centre, Brisbane, Australia
B Griffith University, Brisbane, Australia
C Gold Coast Hospital, Gold Coast, Australia
ELEVATOR PITCH

We have developed a novel surgery duration prediction algorithm that significantly outperforms the current state of the art estimation employed in QLD hospitals and delivers:

• **28%** improvement in procedure duration estimations

• **29%** and **18%** improvement in underestimations and overestimations respectively

Improved surgery duration estimation will lead to better theatre utilization, reduced wait lists and help hospitals achieve NEST target compliance.
SUMMARY

• Key Problem
  • Large numbers of scheduled elective procedures get cancelled before surgery. Primary reason is lack of theatre time due to over-run of other surgeries.
  • Current methods used by hospitals are not accurate enough.

• Aims of this Innovation
  • Developing a predictive model to improve procedure duration estimations and increase theatre utilization.

• What we did
  • Used wide range of potential variables
  • Applied three different state of the art predictive modelling techniques (Linear Regression, Multivariate Adaptive Regression Splines, Random Forests)

• Outcomes
  • Improved surgery duration estimation by 28% compared to current hospital methods
  • Improved underestimations and overestimations by 29% and 18% respectively
BASELINE DATA

- Time estimations prior to this study:
  - 73% historic average time
  - 19% estimates provided by surgeons
  - 8% a default time

- The error of time estimations prior to this study is quite high.

- Baseline time estimation method tend to underestimate procedure times more frequently and this often results in surgery cancellations in hospitals.
METHODOLOGY

• Four years of data from Administrative and Perioperative Databases
  • July 2008 to June 2012
  • 12 specialties, 38520 individual cases
  • 104 different procedures (performed more than 100 times during the period of this study)

• Wide range of predictors
  • Patient characteristics (e.g. age, category, gender, Charlson Comorbidity Index)
  • Operation characteristics (e.g. Unit code, specialty code, theatre, ward, procedure code, session type)
  • Surgery team characteristics (e.g. Surgery team size, Consultant, surgeon)

• Current state of the art predictive modelling techniques (Linear Regression, Multivariate Adaptive Regression Splines, Random Forest)

• Random Forest (Best Model)
  • can handle a large number of predictors
  • combines numerous decision or regression trees in a random process
  • boosts the prediction performance and robustness by taking advantage of the predictive power of each tree
RESULTS

• Cross validation results reveal that the random forest model performs better than other models and reduces mean absolute percentage error by 28% when compared to current hospital estimation approaches.

<table>
<thead>
<tr>
<th></th>
<th>Current Hospital Method</th>
<th>Random Forest</th>
<th>Improvement (%baseline)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMSE</td>
<td>27.88</td>
<td>22.78</td>
<td>18.3</td>
</tr>
<tr>
<td>MAPE</td>
<td>0.95</td>
<td>0.68</td>
<td>28.4</td>
</tr>
<tr>
<td>R-Squared</td>
<td>0.48</td>
<td>0.65</td>
<td>35.4</td>
</tr>
</tbody>
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• The random forest model also significantly improved underestimations and overestimations by 29% and 18% respectively.

• Unlike baseline estimations random forest model distributes estimation error more evenly around zero.

(a) RF model residuals. (b) Current hospital method residuals
Thank you

For more information, please contact:

Zahra Shahabi Kargar
PhD Student
t +61 7 3253 3657
e Zahra.ShahabiKargar@csiro.au
w www.aehrc.com

Sankalp Khanna
Research Scientist
t +61 7 3253 3629
e Sankalp.Khanna@csiro.au
w www.aehrc.com