IE3100M Systems Design Project (Group 16) | Department of Industrial Systems Engineering and Management (ISEM)

ANALYSING AND PREDICTING EMERGENCY SURGERY SCHEDULING TRENDS

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INTRODUCTION

One of Singapore's largest multidisciplinary hospitals sees over 460 patients at its emergency department every day. Due to the unpredictable nature of emergency surgeries, there is a need to monitor and understand the usage of operating theatres for emergency surgeries. The insights could be used to optimize the allocation of its operating theatres. This project aims to formulate predictive models to analyse emergency surgery workload and surgical duration.

OBJECTIVES

1) To improve surgical duration prediction capabilities

2) To identify patterns and trends in occurrence of emergency surgeries

SURGICAL DURATION STUDY

1) DATA CLEANING

*Upon analysing the OT report, several problems are identified from the data

Entry errors	Missing entry	Lack of standardisation
• Eg. Same in OT time and out of OT time (suggesting that surgical duration is zero)	• Eg. Paying status • Eg. OT Chit Priority • Eg. Access to OT	• Different names for same terms (eg. Team 1 is recorded as Team 1/ T1)

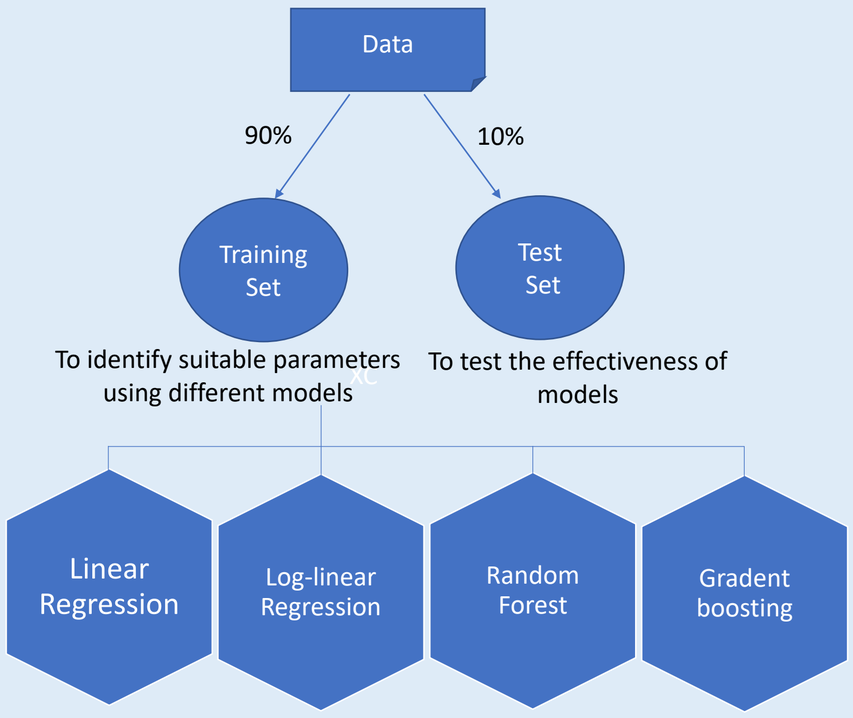
*Attempts were made to clean up the data. For instance, one of the method used is omitting observations with ambiguous surgical duration since it constitutes a small population of the data (<0.17%)

2) DATA ANALYSIS

*Observed that factors provided are categorical and they pose an issue in regression and machine learning
** Resolved using binary variables to quantify categorical factors through R

* Observed that some factors only have a few occurrences (eg.) (<10) which might not be enough data for effective machine learning
** Resolved by excluding these data

3) DATA MINING



Predictor Variables for models:
- Weekday, Month
- OT Chit Priority, Paying Status (PTE/SUB)
- Admit Type, Unscheduled Return to OT, etc.
- Method of operation, Type of operation, etc.

4) MODEL VALIDATION

* Evaluate each model using several performance indicators

	Linear Regression	Log-Linear Regression	Random Forest	Gradient Boosting
MAE (h)	0.555	0.540	0.478	0.486
MAPE	0.415	0.350	0.356	0.358
Std Error (h)	1.03	1.13	0.924	0.941
Max Error (h)	16.22	16.86	15.02	16.56

* Conclude that Random forest model provides the highest accuracy while gradient boosting provides a decent level of accuracy at a relatively fast speed

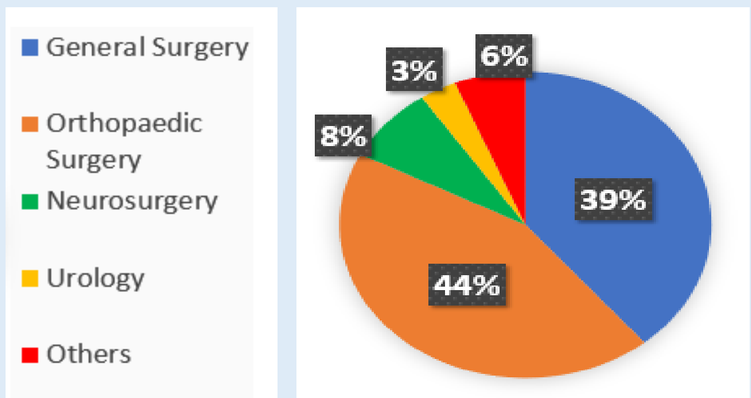
5) LIMITATIONS AND FUTURE IMPROVEMENT

1) Our regression model did not consider interaction variables. There might be interactions between variables which might influence the parameters of the model
2) As there are many categorical variables, other analytical options such as analysis of variances can be explored

SURGICAL WORKLOAD STUDY

Purpose: To look at historical data on emergency surgeries conducted and identify any trends or patterns.

- No clear observable trend found with respect to time
- No correlation found with weather and public holidays
- Top 4 clinical disciplines identified

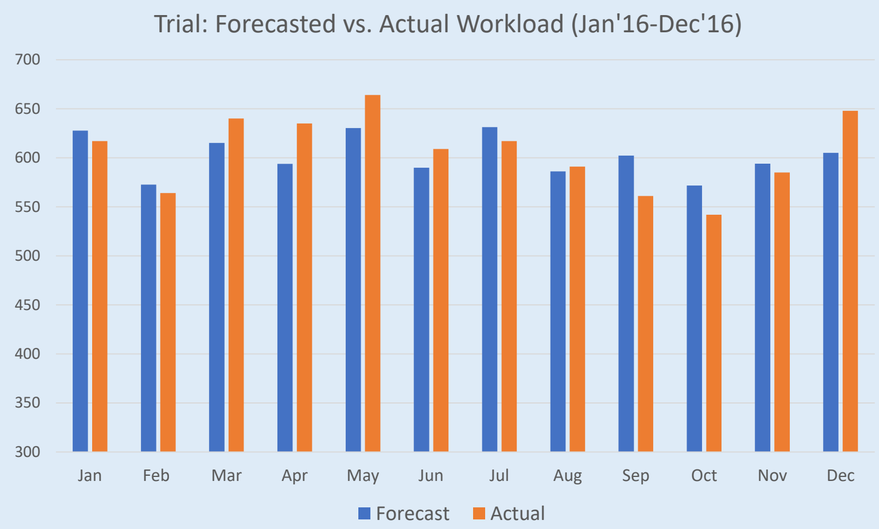


- Workload is first de-seasonalised, forecasted using single exponential smoothing, and then re-seasonalised to obtain the final forecast
- Trials utilizing a smoothing parameter α=0.1 yielded results with mean absolute percentage error of approximately 5%

$$F(t+1)= (\alpha)*D(t) + (1-\alpha)*F(t)$$

F(t) is the forecast for month t,
D(t) is the workload in month t,
α is the smoothing parameter.

Seasonal factors	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Emergency	1.04	0.95	1.03	0.99	1.04	0.97	1.03	0.96	0.99	0.94	0.98	1.00



A simple user-friendly tool can be conceptualized in Microsoft Excel to carry out the forecast.

Input Parameters	
Current month	
Workload of current month	
Previous forecast	
Smoothing Parameter (0<α<1)	
Output	
Forecast of next month	
Average no. of cases/day	

KEY SKILLSETS

1) Organising and cleaning up large volume of data for analysis.

2) Applying statistical analysis such as demand forecasting and regression on data to identify trends and patterns.

3) Creating statistical tools for prediction and estimations of operating variables.