Utilising Machine Learning in a Robust Joint Model Setting

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Since April 2020, vast amounts of data have been collected by researchers in Queen's University Belfast on patients' journeys through the Intensive Care Unit (ICU) at The Royal Victoria Hospital, Belfast. The proposed PhD will develop new statistical theory to better account for and analyse the intricacies of such data, working closely with a consultant in respiratory medicine in The Royal Victoria Hospital Belfast and Dr Charles Gillan, a Senior Lecturer in Computer Science, to put this theory into practice. As such, it is an exciting opportunity to make real world impacts for ICU patients.

The novel methods that will be developed in this project will be used to identify the risk factors of serious adverse events and generate dynamic predictions that will be incorporated into an early warning system to aid ICU staff. Whilst mechanical ventilation is a life-saving therapy, it does unfortunately pose risks to patients. The early identification and development of preventative strategies is crucial to ultimately improve the survival prognosis of patients who require mechanical ventilation.

This project will develop new robust joint modelling approaches to simultaneously analyse the repeated measurements (longitudinal data) collected from ICU patients during their stay in hospital, and the impact the dynamic changes in these biomarkers have on the patient's prognosis (McFetridge 2021). In particular, this work will capitalise on the accuracy of machine learning techniques through the incorporation of survival trees and random survival forests to better capture the time-to-event process.

Survival forests are an ensemble technique, similar to random forests (Breiman 2001), which are applied within a time-to-event context (Ishwaran 2008). They have been shown to produce highly accurate ensemble predictors, improving predictive accuracy compared to standard survival models, such as Cox regression. Their utilisation within a robust joint model setting thus will provide more precise dynamic individualised survival predictions, simultaneously accounting for the evolution of biomarkers over time and the potential for the common presence of outlying individuals whose trends don't conform to population averages. Such robust approaches will lay the foundations of the much-needed early warning system in the ICU for serious adverse events.

This PhD will feed into a wider collection of projects focused on the development and refinement of the early warning system, with the student working closely with the entire research team to implement the desired real-world impacts.

For further details about the project, please contact the primary supervisor (k.cairns@qub.ac.uk).

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