Ryan Leadbetter presents Bayesian Hierarchical Modelling of Equipment Reliability in Mining: A Pragmatic Approach

On Wednesday 13 December at 1.30AWST - Ryan will present Bayesian Hierarchical Modelling of Equipment Reliability in Mining: A Pragmatic Approach for his PhD research for his Milestone 3

To attend Ryan's presentation virtually click on Microsoft Teams meeting

The consistent and efficient operation of iron ore machinery from pit to port is essential for maximising profits. To this end, reliability modelling is an invaluable tool for improving the design and execution of the maintenance strategies that ensure the reliable operation of mining machinery. There are well-established reliability models in the literature. Still, there needs to be more clarity between this literature and what is done by practitioners in the mining industry, a theory-practice gap. This gap exists because of the imperfect reality of collecting data in the field--data sets that are small, incomplete, noisy, or all three--and the need for methods for expanding reliability modelling to account for these imperfections. Ryan's industry-linked PhD has aimed to reduce this gap by demonstrating how the Bayesian statistical modelling framework can address some of the common problems faced when fitting models to such reliability data in mining applications.

In the first part of the work, Ryan adapts and evaluates a method for constructing an informative joint prior distribution for the parameters of Weibull lifetime analysis to combat bias introduced through heavily censored lifetime data. Ryan will illustrate the bias caused by heavy censoring and then show how encoding domain information into a joint prior for the two Weibull parameters constrains the bias. Secondly, he will evaluate the proposed method through a simulation study. Finally, Ryan will provide recommendations on applying the method in practice and demonstrate on an industry data set from an overland iron ore conveyor.

In the second part of the work, Ryan focuses on degradation modelling. Particularly how the Bayesian hierarchical framework can extend the gamma stochastic degradation process to noisy observations and then to the degradation of surfaces; in doing so, Ryan simplifies some of the literature on noisy gamma processes by demonstrating how separating the observation-degradation process into two separate conditional models removes the need for complicated inferential algorithms. Furthermore, Ryan will show the hierarchical model's implementation using flexible tools that are accessible to a wider reliability audience. Ryan also shows how reparameterising can make the gamma process more interpretable, simplifying prior specifications and further model expansions. Taking this one step further, I expand the noisy gamma process to functional data analysis to model the degrading surface of conveyor belting.

Throughout the work, I emphasise how complicated reliability processes found in practice can be broken down into manageable sub-models and how these models can be fit, evaluated, expanded, and compared using a Bayesian workflow considered good statistical practice. In doing so, Ryan hopes to contribute more significantly by providing an applied case study of the Bayesian workflow in a reliability setting that other applied reliability practitioners can use to develop solutions for new problems.

Supervisors: Dr Aloke Phatak **Co-supervisors:** Prof. Chris Aldrich **Co-supervisors A/Prof.**Michael Small **Chairperson:** Prof. Felix Chan

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