Doctor of Business Economics

On Models and Metrics:
Improving Stochastic Model Performance in Manpower Planning

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Summary

When scientists stumble upon an intriguing scientific modelling problem, they face some crucial decisions. They need to select an appropriate framework for addressing the modelling challenge, comprising two essential aspects. Firstly, they need to determine the most suitable model type for the specific problem. Additionally, and often overlooked, they must define the criteria that will be used to judge the performance of the models at hand – in other words, they need to set the indicators to tell apart good from bad performing models. This PhD thesis contributes to both facets of this framework within the context of manpower planning.

In the first chapter, we delve into existing models and their properties seeking to generalise them to various settings. Specifically, the concept of maintainability for Markov chains is explored for and extended to semi-Markov chains. This extension leads to the introduction of the new concept of 'state re-union maintainability'.

The second chapter is devoted to attainability for Markov and semi-Markov chains. Based on the insights from the first chapter, the concept of 'state re-union attainability' is developed and explored.

The notion of model selection emerges in the third chapter when balancing the importance of goodness of fit with the number of estimated parameters. Here, the focus is on the use of semi-Markov models. Leveraging well-defined model criteria, a novel model type is developed, termed the 'hybrid semi-Markov model'. The chapter highlights the need for the right model type selection to effectively handle the trade-off between Markov and semi-Markov models. In the fourth chapter, the emphasis further shifts to model evaluation metrics. Within the realm of uplift modelling, the Qini score is considered the golden standard for evaluation purposes but lacks theoretical foundation. To address this, a novel metric inspired by the Receiver Operating Characteristic (ROC) curve, named the ROCini score, is developed here. The ideas behind this metric are then

used in the context of ordinal dominance graphs, leading to the creation of the pROCini score. This chapter concludes with a simulation study that empirically validates the improved discriminative power of the (p)ROCini scores compared to the Qini score.

By addressing these aspects, this thesis aims to enhance our understanding of modelling choices and criteria for assessing model effectiveness in the context of manpower planning and related fields.