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Beyond Traditional Boundaries: Harnessing the Power of Deep Learning for Enhanced Survival Analysis and Interpretability

Adam Goran*

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Abstract

Survival analysis is a key statistical method for studying time-to-event data, which plays a critical role in various fields, including medicine, finance, and social sciences. A traditional and still popular model in this context is the Cox proportional hazards model. Despite its widespread use, it relies on assumptions that may not hold in real-world scenarios, leading to potential inaccuracies in predictions. This master thesis investigates the application of deep learning techniques, specifically a special type of neural network model, to overcome the limitations of the traditional Cox model and provide a more flexible approach to survival analysis.

The `DeepHit` model is a deep learning-based approach that adapts to complex relationships in the data without relying on restrictive assumptions. We compare the performance of the Cox model and the `DeepHit` model through simulation experiments and a real data experiment, demonstrating the strengths and weaknesses of each approach. The results indicate that the `DeepHit` model can outperform the Cox model in certain cases, particularly when the assumptions of the Cox model are violated.

Moreover, the thesis addresses the interpretability issue commonly associated with deep learning models by introducing SHAP (SHapley Additive exPlanation) values to approximate and explain the predictions made by the `DeepHit` model. This addition enhances the practicality of the `DeepHit` model for real-world applications, especially in medical applications, where understanding a model can be crucial.

In conclusion, this thesis advocates for the adoption of more sophisticated methods, such as deep learning techniques, in survival analysis to avoid making restrictive assumptions about the data at hand. The findings contribute valuable insights for practitioners and researchers in the field, encouraging the exploration and refinement of advanced methods for improved performance across various applications. Recent advancements in deep learning demonstrates its seemingly unlimited potential in numerous fields.

*Postal address: Mathematical Statistics, Stockholm University, SE-106 91, Sweden. E-mail: adamgoran1999@gmail.com. Supervisor: Chun-Biu Li & Marie Linder.