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Early Behavioural Risk Assessment in Telematics Insurance: The Role of Heatmap Resolution and Observational Data Availability

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Abstract

Motor insurance pricing has traditionally relied primarily on policyholder and vehicle characteristics for risk assessment and premium setting. Telematics-based insurance extends this framework by enabling personalised behavioural risk assessment based on how policyholders actually drive. While telematics data are rich and complex, one practical representation is velocity–acceleration (v-a) heatmaps, which have previously been shown to improve claims prediction beyond models based solely on traditional risk factors. However, an important unresolved question remains: how does the granularity of the heatmap representation, together with observational data availability, affect claims prediction performance?

This thesis addresses this question primarily through a controlled simulation study, where the underlying claim-generating mechanism is known. Three heatmap resolutions and three levels of observational sample size are considered in order to assess how predictive performance is affected under varying levels of observational data availability. Principal component analysis (PCA) and bottleneck neural networks (BNN) are used to construct dimension-reduced representations of the heatmaps, which are subsequently incorporated into a Poisson generalised additive model (GAM) for claims frequency modelling. A complementary real-data application using telematics data from Paydrive AB, a Swedish telematics-based motor insurer, is also included to assess practical relevance.

The simulation results suggest a trade-off between the greater robustness of lower-resolution heatmaps under limited observational data and the richer behavioural structure captured by finer heatmaps. Lower-resolution heatmaps generally allow behavioural patterns to be estimated more reliably under limited observational data, though in some cases with slightly weaker predictive performance, while finer heatmaps capture richer behavioural structure but appear more sensitive to observational scarcity. Overall, the findings suggest that an intermediate heatmap resolution may represent a practical compromise between predictive performance and observational data requirements.

From a practical insurance perspective, these findings are relevant not only for the design of telematics-based insurance models, but also for the broader challenge of assessing behavioural risk reliably at an early stage. Earlier identification of high-risk driving behaviour could improve pricing accuracy, portfolio management, and potentially enable earlier intervention to reduce future claims.

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