A discrete bivariate distribution and its natural conjugate with applications in bonus-malus systems: the case of independence and dependence

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Abstract

This work addresses a significant issue with the current bonus-malus automobile insurance systems. The problem is how premiums are calculated based solely on the number of claims. While simple, this approach fails to consider the size of the claims, resulting in a system that penalizes all policyholders equally, regardless of the severity of their claims. This lack of differentiation is an apparent injustice that needs to be rectified. To address this issue, we propose a new approach that incorporates the size of claims into the bonus-malus system. We do this by introducing a bivariate model, which means we're considering two factors: the number of claims and the size. This model allows us to differentiate between two types of claims, and we further refine it by introducing a priori distribution for the risk factors assigned to these claims. Initially, we assume independence between these factors but also explore the possibility of dependence. For the first case, the a priori distribution is conjugated with the likelihood, and the premiums obtained in this model can be expressed as credibility formulas that satisfy specific transition rules. As an illustration, bonus-malus premiums are obtained and compared with those obtained under the classical Poisson-gamma model in which only the number of claims without distinction between amounts is considered.

Keywords: Automobile; Bayesian; Credibility; Insurance; Bivariate Distribution.

References

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