

CREST - GENES

Cours doctoraux 2025

TOPICS IN ACTUARIAL SCIENCE

WHAT IS A WELL-CALIBRATED PURE PREMIUM MODEL? REVIEW OF RECENT RESULTS AND AVENUES FOR REFLECTION

Julien TRUFIN

Université Libre de Bruxelles (ULB)

SCHEDULE	Monday	10 March 2025 17 March 2025	From 10:15 to 13:15	Room 2045
	Thursday	13 March 2025 20 March 2025	From 10:15 to 13:15	Room 2045

Abstract

Machine learning techniques provide actuaries with predictors exhibiting high correlation with claim frequencies and severities. In a first time, we review some of the machine learning techniques used in non-life insurance pricing, including random forests, gradient boosting trees, and neural networks.

The predictors obtained based on these machine learning techniques generally fail to achieve financial equilibrium. Autocalibration effectively addresses this issue since it ensures that every group of policyholders paying the same premium is on average self-financing. In a second time, this course proposes to look at recent results concerning autocalibration. In particular, we present a new characterization of autocalibration which enables to identify whether a predictor is autocalibrated or not, we study a method (called balance correction) for obtaining an autocalibrated predictor from any regression model, we highlight the effect of balance correction on resulting pure premiums, and we go through some performances criteria that are particularly relevant for autocalibrated predictors.

Course outline

- Pure premium models and regression techniques such as random forests, gradient boosting trees and neural networks
- Financial equilibrium requirements for a pure premium model :
 - Statistical tests to verify the self-financing of risk classes resulting from a pure premium model
 - Correction of a pure premium model to achieve the self-financing of its risk classes, with a particular focus on monotone regression (isotonic regression)
- Review of performance indicators of prediction models traditionally used by actuaries and evaluation of their relevance in the context of pure premium modeling
- Avenues for reflection on the calibration of pure premium models and future research

Format, pre-requisites and audience

Students need to have knowledge about regression models and non-life insurance pricing.

Evaluation

The evaluation will be based on a project.

References

Denuit, M., Charpentier, A., Trufin, J. (2021). Autocalibration and Tweedie-dominance for insurance pricing with machine learning. *Insurance: Mathematics and Economics* 101, 485-497.

Denuit, M., Hainaut, D. , Trufin, J. (2019). *Effective Statistical Learning Methods for Actuaries I: GLMs and Extensions*, Springer Actuarial Series.

Denuit, M., Hainaut, D. , Trufin, J. (2019). *Effective Statistical Learning Methods for Actuaries III: Neural Networks and Extensions*, Springer Actuarial Series.

Denuit, M., Hainaut, D., Trufin, J. (2020). *Effective Statistical Learning Methods for Actuaries II: Tree-based Methods and Extensions*, Springer Actuarial Series.

Denuit, M., Huyghe, J., Trufin, J., Verdebout, T. (2024). Testing for auto-calibration with Lorenz and Concentration curves. *Insurance: Mathematics and Economics* 117, 130-139.

Denuit, M., Sznajder, D., Trufin, J. (2019). Model selection based on Lorenz and concentration curves, Gini indices and convex order. *Insurance: Mathematics and Economics*, 89, 128-139.

Denuit, M., Trufin, J. (2023). Model selection with Pearson's correlation, concentration and Lorenz curves under autocalibration. *European Actuarial Journal* 13, 871-878.

Wüthrich, M. V. (2020). Bias regularization in neural network models for general insurance pricing. *European Actuarial Journal* 10, 179-202.

Wüthrich, M. V., Ziegel, J. (2024). Isotonic recalibration under a low signal-to-noise ratio. *Scandinavian Actuarial Journal*, 2024(3), 279–299.