Generative AI and scenario generation in insurance

The aim of this project is to design Generative AI methods to generate scenarios of catastrophic events, taking into account the spatial dependence of the losses and the fact that the distributions are heavy tail.

The viability of an insurance portfolio depends on the number of future claims. The premiums that are collected must be sufficient to absorb the cost of future events. By absorb, one means that the available funds must be sufficient even for pessimistic scenarios that occur with very low probability (0.5% under the European Solvency II regulation). In this context, the problem is not only to predict the most likely outcome but also to understand the tail of the distribution of the loss.

Scenario generation essentially in two cases:

- simulation of catastrophic events, in order to challenge the robustness of the portfolio (somehow similar to "stress tests");
- projection of future trends in more long-term perspective.

Generative AI methods are promising tools to perform this scenario simulation. However, standard methods may miss capturing the behavior of the tail of the distribution, because it corresponds to rare events, and the size of the learning sample is usually too small.

Recently, several techniques have been proposed to extend generative methods in the context of simulation of extreme events, see for example Allouche et al. (2022) and Lhaut et al. (2025) who developed GAN techniques, and Lafon et al. (2023) who developed a VAE approach.

The aim of this project is to adapt these techniques to the particular case of simulation of insurance scenarios in the case of climate risk, with the constraint to integrate covariates that can be used for projecting the risk at a given horizon. Two particular risk will be considered: drought (which is a major concern due to the problem related to subsidence relative to clay shrink-swell, see for example Heranval et al. (2023)), and hail (see for example Miralles, Davison (2024)).

References

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