SCOR-UQAM NEWSLETTER #3 (October 2024-March 2025)

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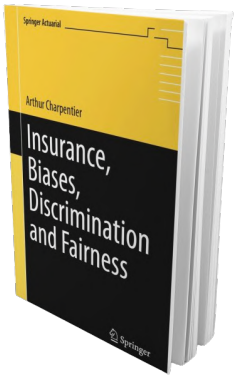
"Technology is neither good nor bad, nor is it neutral." Kransberg (1986)[1]

The research project "fairness of predictive models: an application to insurance markets" aims to reflect on the algorithmic fairness of predictive models, more particularly in the context of insurance markets.

This project, funded by the SCOR Foundation for Science, began on October 1st, 2023, led by Arthur Charpentier, professor at the Université du Québec à Montréal (UQAM), for three years. We publish a newsletter every six months to provide an overview of recent activity. For the first time, we are releasing a version in French Infolettre #3 ↷.



So here we are, halfway through the project, eighteen months after its launch. Following the publication of the book **Insurance, Biases, Discrimination and Fairness** (in English, presented in Newsletter #2 ↷), activity has slowed down a bit. As winter set in, the interns left, and we resumed our daily activities, progressing in the writing of articles and presenting our work (notably at NeurIPS and AAAI, page 18). We also organized a very successful conference in Guanajuato, Mexico (see page 16), with another one planned for mid-May, this time in Paris (we will discuss it on page 21, and in the next newsletter).

Here's a quick overview of our activities over the past six months. We revisited competitive insurance markets, addressing issues of fairness (Selection bias in insurance: why portfolio-specific fairness fails to extend market-wide), algorithmic collusion (Beyond human intervention: algorithmic collusion through multi-agent learning strategies), interactions with digital players (The insurance market in the era of digital transitions), The role of government vs. private sector provision of insurance, as well as an article in the newspaper *Le Monde*, Wildfires in California and natural disaster insurance). We also examine approaches related to fairness, with a short article Insurance analytics: prediction, explainability and fairness providing a brief state-of-the-art review, a dissemination article Moral maze: ethics and discrimination in machine learning aimed at actuaries, as well as A comment on the proposed automobile insurance rating and underwriting supervision guidance for regulators in Ontario. Let us mention a more legal article (The existence of gender bias through the use of algorithms in decision-making processes in liability and insurance law) and more mathematical articles, including Optimal transport on compositional data for conterfactuals and Equipy, sequential fairness using optimal transport are presented.

Finally, several articles revisit learning models: Post-calibration techniques: balancing calibration and score distribution alignment gets back on recalibration, Data augmentation with variational autoencoder for imbalanced dataset on the difficulty of predicting imbalanced data, k-nearest neighbors and k-means in Gini prametric spaces on handling outliers, Hoeffding decomposition of black-box models with dependent inputs on formal challenges in explainability approaches (when inputs are correlated), Functional central limit theorems for epidemic models with varying infectivity and waning immunity on epidemiology issues (variable infectivity and waning immunity), and a short article on learning algorithms and AI in economics (Machine learning and economics).

In addition to academic publications, magazines such as *The Actuary* (page 12), *Risques* (13-14), *The European Actuary* or *l'Actuariel* from the French Institute of Actuairies (15) review our work related to this project.

See https://freakonometrics.hypotheses.org/

[1] Melvin Kranzberg is an American historian who set out six laws of technology in a "Presidential Address" in the journal *Technology and Culture*, which he founded. This is the first law.

People involved

After a busy summer hosting several interns (Newsletter #2), two postdoctoral researchers have joined the team (Marouane Il-Idrissi and Arsène Brice Zotsa Ngoufack, page 3).

Interns

Arthur Charpentier is participating in the supervision of an internship in France, with **Laurence Barry** (see Newsletter #2) and the PARI Chair ("*research program on the apprehension of risks and uncertainties*,"), which began at the end of March.

Raphaël Dalbarade (alumni: MSc ENSAE, BSc Université Paris Saclay, France) has started working on **game theory and natural disasters**, as well as market dynamics in a coverage mechanism context, in France, based on "national solidarity,"

What happened to them?

Ana Patrón Piñerez (Newsletter #2), who was a MITACS Globalink intern last summer, is completing an MSc on the use of neural networks to compute the Bayesian Nash equilibrium in auction games. She is expected to continue with a PhD afterward. We have also finalized an article together following her internship in Montreal, presented by Agathe in Bruxelles (see page 19),

Franklin Feukam Kouhoue (Newsletter #2, ENSAE alumni), who wrote his MSc thesis on "Interpretability of actuarial models in pricing," supervised by Arthur Charpentier and Laurence Barry, received the "Quant Awards" prize from the *Enterprise Risk Management* department of Natixis in Paris,

A thought for the students who have ended up in Paris, including Florent Crouzet, who came last summer (Newsletter #2), Suzie Grondin, who came last winter (Newsletter #1), Bertille Tierney (student, page 4), Maxence Colin (student), Agathe Fernandes Machado (PhD student), and François Hu (former postdoctoral fellow, Newsletter #1).

PhD Students

Two PhD students are still involved in the work, **Agathe Fernandes Machado** and **Olivier Côté** (Newsletter #1). Both successfully completed their final doctoral exam at the end of autumn

After attending NeurIPS in Vancouver (see page 18) in December, Agathe was invited to Paris by **Stéphane Loisel** (CNAM, Conservatoire National des Arts et Métiers, France) and **François Hu** (Milliman, France). She obtained a CRM-CNRS scholarship. She then traveled to Brussels to present at a conference (see page 19) and at several other events (see page 20).

Postdoctoral fellows

Marouane Il Idrissi (alumni: PhD Université de Toulouse, MSc Université de Rennes and MSc ENSAI, France), joined the team to work on interpretability for machine learning, supervised by **Arthur Charpentier** and **Marie-Pier Côté** (Université Laval, in Québec)

Marouane defended his thesis, supervised by **Nicolas Bousquet**, **Fabrice Gamboa**, **Bertrand Iooss**, and **Jean-Michel Loubes**, on **Development of interpretability methods in machine learning for the certification of artificial intelligence related to critical systems.**

Arsène Brice Zotsa Ngoufack (alumni: PhD Université d'Aix-Marseille, MSc Université de Yaoundé in Cameroon and MSc Université Felix Houphouet Boigny, Abidjan, Ivory Coast), came to work on contagion and stochastic processes for machine learning.

He is supervised by **Arthur Charpentier** and **Hélène Guérin** (UQAM, in Montréal). Brice defended a thesis on **Generalization of epidemic models with variable susceptibility**, supervised by **Raphael Forien** and **Étienne Pardoux**.

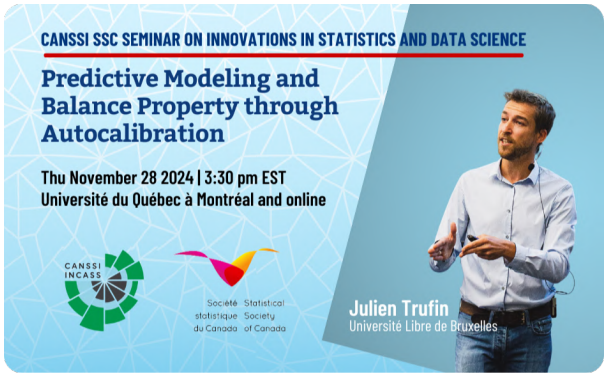
Others

Other people have been involved in the work over the past few months.

Emmanuel Flachaire, professor at the Aix-Marseille School of Economics (AMSE, France), visited for two weeks in October to work with Arthur Charpentier, Agathe Fernandes Machado, and Ewen Gallic on **the estimation of conditional average treatment effects** in causal inference,

Julien Trufin, professor at the Université Libre de Bruxelles (ULB, Belgium), visited for a week in November as an external jury member for Agathe's intermediate exam. He will return in the spring

Beyond the working sessions, Julien Trufin also gave a talk on **the calibration of predictive models** as part of one of the inaugural events of the Seminar on Innovations in Statistics and Data Science, organized by CANSSI (Canadian Statistical Sciences Institute), the SSC (Statistical Society of Canada), and StatQAM, the statistics group at UQAM (of which Arthur is a member).



François Hu, former postdoctoral researcher at the Université de Montréal under the supervision of Arthur Charpentier, working on fairness with optimal transport, returned for a short visit this fall, for Halloween.

François is now a principal AI researcher at Milliman and teaches the course on fairness in insurance at the Conservatoire National des Arts & Métiers (CNAM) in Paris. Agathe Fernandes Machado visited him in January, and Arthur Charpentier will present at Milliman's R&D seminar in May (with Olivier). François will conclude the workshop organized at SCOR in May, mentioned on page 21.

Together with **Bertille Tierny** (alumni: MSc ESCP Business School and MSc ENSAE Paris, France), Arthur and François are working on "in-processing" approaches to ensure fairness, .

Finally, **Laurence Barry** (introduced in Newsletter #2), with whom the work continues, together with **Pierre François** , CNRS research director, led the renewal of the PARI Chair (research program on risk and uncertainty assessment), under the auspices of the Louis Bachelier Institute, in partnership with ENSAE / CREST and Sciences Po. Arthur Charpentier is a member of the group .

Miscellaneous

Chinese hot pot[2] and Christmas sweaters.

(from left to right: top, Brice (postdoc), Marouane (postdoc), Agathe (PhD student), Jean-François (professor); bottom, Hélène (professor), Ewen (visiting professor), Tommy (MSc student), Issam (postdoc) and Dante (postdoc)).

As the majority of the team's students and trainees are of foreign origin, we have become accustomed to organizing an annual outing to the "cabane à sucres", in keeping with this Spring Québec tradition.

(with Brice (postdoc), Marouane (postdoc), Agathe (doctorante), Hélène (professor), Olivier (PhD) Ewen (invited professor), Tommy (MSc), Dante (postdoc), Marie (professor at Heriot-Watt, Edimbourg), and some "plus one")

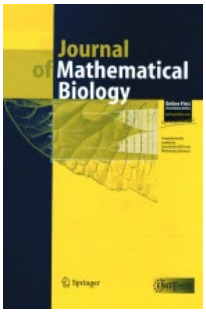
Maple sugar season, *spring harvest of sugar bushes marks the end of winter, and becomes a pretext for festivities and celebrations for visitors to the sugar shacks.*

[2] Chinese hot pot is inclusive enough to allow for all kinds of diets, and everyone feels welcome.

Recent work

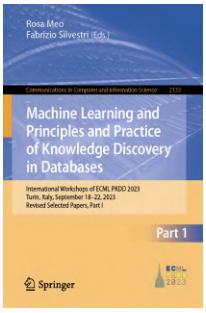
In these newsletters, we mention articles as soon as they become "pre-print", available on ArXiv or SSRN. Most are then sent to international peer-reviewed journals for publication. Some of the articles featured in (Newsletter #1 and #2) have been published this Winter. Other articles, later called "dissemination" articles, are more for the general public. Professional' articles and reports are notes written for regulatory authorities or professional associations.

Publications



Optimal Vaccination Policy to Prevent Endemicity: a Stochastic Model, by Félix Foutel-Rodier, Hélène Guérin and Arthur Charpentier, was published in the *Journal of Mathematical Biology*,

doi:10.1007/s00285-024-02171-z,



Mitigating Discrimination in Insurance with Wasserstein Barycenters, by Arthur Charpentier, François Hu and Philipp Ratz, was published in *Machine Learning and Principles and Practice of Knowledge Discovery in Databases*,

doi:10.1007/978-3-031-74630-7_11,

A fair price to pay: exploiting causal graphs for fairness in insurance, by Olivier Côté, Marie-Pier Côté and Arthur Charpentier, was published in the *Journal of Risk and Insurance*,

doi:10.1111/jori.12503,

Artificial intelligence and personalization of insurance: Failure or delayed ignition?, by Arthur Charpentier and Xavier Vamparys was published in *Big Data & Society*,

doi:10.1177/20539517241291817,

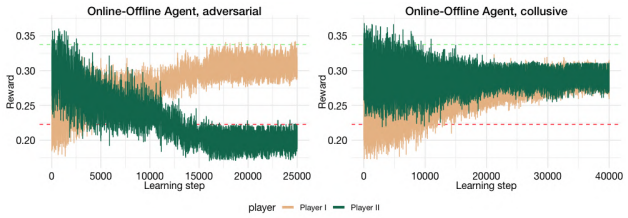
The article was mentioned in the Newsletter #1, while Arthur was invited to discuss it on Twitch, in French, *au pied de la lettre*, for the *Lettre de l'Assurance*.

Arthur Charpentier also published some articles in *Risques*, the quartely magazine of France Assureurs page 13 and page 14.

Beyond human intervention: algorithmic collusion through multi-agent learning strategies

by Suzie Grondin (intern in the Summer and Fall 2023, Newsletter #1), Arthur Charpentier and Philipp Ratz (former PhD student), doi:10.48550/arXiv.2501.16935

> *Collusion is a phenomenon often associated with human actions, and raises concerns about its potential presence in algorithmic decision-making. This study shows that algorithmic behaviors often attributed to collusion may in fact stem from optimization strategies. However, some algorithms use adversarial learning to manipulate competitors in order to set collusive prices. The literature has drawn divergent conclusions on this subject. This article aims to clarify these results.*



A preliminary version of this work was presented by Arthur Charpentier at the **Optimization Days** last Spring (organized at HEC Montréal) Newsletter #2.

The role of government vs. private sector provision of insurance

by Arthur Charpentier, published in the *Journal of Risk and Insurance* doi:10.1111/jori.12497. This short article was an introduction to a special issue of the journal,.

> *This special issue explores the evolving role of government versus private sector involvement in insurance markets, focusing on how market failures, such as adverse selection and moral hazard, justify government intervention in risk management. The issue presents three articles that address both challenges and opportunities in insurance provision: the efficiency of institutions managing interdependent risks, the dynamics between moral hazard and insurer effort in disability insurance, and the impacts of subsidized flood insurance on real estate markets. Together, these studies highlight the complex interactions between public and private insurance solutions and suggest pathways for improving efficiency, fairness, and resilience in insurance markets.*

Arthur was the editor of the special issue, where three articles were finally published, Koning & van Lent (2024) on disability insurance, Lee, Garbarino & Guin (2024) on floods and Seog (2024) on interdependancies.

Selection bias in insurance: why portfolio-specific fairness fails to extend market-wide

by Olivier Côté, Marie-Pier Côté (professor at Université Laval) and Arthur Charpentier, SSRN: 5018749

> *In insurance, the scope of fairness is the entire insured population, not solely an insurer's clients. However, each insurance company's portfolio represents a skewed subsample. Models fit to these selection-biased data do not generalize well for the broader population of insureds. Two biases stem from portfolio composition: representation bias, when large prediction errors are made on individuals from subpopulations infrequently observed, and selection bias, when underwriting and marketing skew the portfolio away from the insured population. We examine how portfolio composition affects fair premium methodologies for mitigating direct and indirect discrimination on a protected attribute. We illustrate how unfairness mitigation based on a selection-biased portfolio does not yield a fair market from the perspective of insureds. Relying on causal inference and a portfolio composition indicator, we describe the selection mechanism and determine conditions under which each bias affects various fairness-adjusted premiums. We propose a method to recover the population-wide fairness-adjusted premiums from selection-biased data, by using a (third-party provided) unbiased estimate of the prohibited attribute distribution. We show that this approach effectively mitigates selection bias but leads to overall premiums that are not balanced. In a limiting case, we show that portfolio-specific fairness-aware premiums can lead to a market-wide unawareness strategy: portfolio composition opens the back door to proxy discrimination.*

This work has been already be presented several times, see page 19.

Equipy, sequential fairness using optimal transport

by Suzie Grondin, Agathe Fernandes Machado, Arthur Charpentier, Philipp Ratz and François Hu, ArXiv:2503.09866, illustrating the methodology implemented in the python package `equipy` to make a predictor fair (according to a demographic parity criterion, with respect to one or more sensitive attributes).

> *Algorithmic fairness has recently received considerable attention due to the failings of various AI predictive systems, which have been shown to be unfairly biased against population subgroups. While many approaches have been proposed to mitigate these biases in predictive systems, they often struggle to provide accurate estimates and transparent correction mechanisms in the case where multiple sensitive variables, such as a combination of gender and race, are involved. This article introduces a new open-source Python package, EquiPy, which provides an easy-to-use, model-agnostic toolkit for efficiently achieving fairness across multiple sensitive variables. It also offers comprehensive graphical utilities to enable the user to interpret the influence of each sensitive variable in a global context. It uses theoretical results to break down the complexities arising from the use of multiple variables into simpler-to-solve subproblems. We demonstrate the ease of use for mitigation and interpretation on public data derived from the US Census, and provide sample code for its use.*

This work was based on code used for our work on Wasserstein barycenters, presented at the 38th AAAI conference in Vancover (Newsletter #1). Suzie Grondin was intern with us, and Agathe just started her PhD. They both decided to join the project and help us.

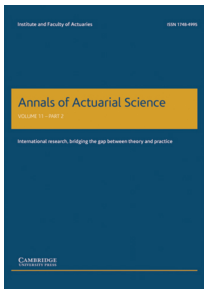
This article was presented at the events **WIM** (Workshop on Insurance Mathematics), **IDSC'24**, and at the **Second Workshop on Fairness and Discrimination in Insurance** (organized in Québec City, Newsletter #2).

Insurance analytics: prediction, explainability and fairness

by Kjersti Aas (Norwegian Computing Center & Norwegian University of Science and Technology), Arthur Charpentier, Fei Huang (Newsletter #2, University of New South Wales) and Ronald Richman (Old Mutual Insure and University of the Witwatersrand), published in the *Annals of Actuarial Science*, doi:10.1017/S1748499524000289

> *The expanding application of advanced analytics in insurance has generated numerous opportunities, such as more accurate predictive modeling powered by Machine Learning and Artificial Intelligence (AI) methods, the utilization of novel and unstructured datasets, and the automation of key operations. Significant advances in these areas are being made through novel applications and adaptations of predictive modeling techniques for insurance purposes, while, concurrently, rapid advances in machine learning methods are being made outside of the insurance sector. However, these innovations also bring substantial challenges, particularly around the transparency, explanation, and fairness of complex algorithmic models and the economic and societal impacts of their adoption in decision-making. As insurance is a highly regulated industry, models may be required by regulators to be explainable, in order to enable analysis of the basis for decision making. Due to the societal importance of insurance, significant attention is being paid to ensuring that insurance models do not discriminate unfairly.*

Arthur was co-editor of the special issue, in which half a dozen articles were published, Campo & Antonio (2024), Jose, Macdonald, Tzougas & Streftaris (2024), Lee Jeong (2024), Lindholm & Palmquist (2024), Maillart & Robert (2024), Richman & Wüthrich (2024) and Wu, Chen, Xu, Pan & Zhu (2024).



Data augmentation with variational autoencoder for imbalanced dataset

by Samuel Stocksieker (former PhD student, Newsletter #2), Denys Pommeret (professor at the Université Aix-Marseille) and Arthur Charpentier doi:10.48550/arXiv.2412.07039 . This work was presented by Samuel at the *31st International Conference on Neural Information Processing* (ICONIP'24)

> *Learning from an imbalanced distribution presents a major challenge in predictive modeling, as it generally leads to a reduction in the performance of standard algorithms. Various approaches exist to address this issue, but many of them concern classification problems, with a limited focus on regression. In this paper, we introduce a novel method aimed at enhancing learning on tabular data in the Imbalanced Regression (IR) framework, which remains a significant problem. We propose to use variational autoencoders (VAE) which are known as a powerful tool for synthetic data generation, offering an interesting approach to modeling and capturing latent representations of complex distributions. However, VAEs can be inefficient when dealing with IR. Therefore, we develop a novel approach for generating data, combining VAE with a smoothed bootstrap, specifically designed to address the challenges of IR. We numerically investigate the scope of this method by comparing it against its competitors on simulations and datasets known for IR.*

Post-calibration techniques: balancing calibration and score distribution alignment

by Agathe Fernandes Machado, Arthur Charpentier, Emmanuel Flachaire, Ewen Gallic and François Hu was published in the Proccedings of the *Workshop on Bayesian Decision-making and Uncertainty*, at the *38th Conference on Neural Information Processing Systems (NeurIPS 2024)*, openreview:TIy0QuWPuE).

> *A binary scoring classifier can appear well-calibrated according to standard calibration metrics, even when the distribution of scores does not align with the distribution of the true events. In this paper, we investigate the impact of post-processing calibration on the score distribution (sometimes named "recalibration"). Using simulated data, where the true probability is known, followed by real-world datasets with prior knowledge on event distributions, we compare the performance of an XGBoost model before and after applying calibration techniques. The results show that while applying methods such as Platt scaling, Beta calibration, or isotonic regression can improve the model's calibration, they may also lead to an increase in the divergence between the score distribution and the underlying event probability distribution.*

See also page 18 for more details.

The insurance market in the era of digital transitions

by Arthur Charpentier and Raphaël Suire, (professor à l'Université de Nantes en France), published by the *Society of Actuaries*, on identifying relationships between insurers, Big Tech and insurtechs.

> *The digital revolution has profoundly transformed market dynamics, particularly within the insurance sector. This transformation encompasses the infrastructure and technologies that facilitate information exchange, the emergence of new business practices, and the rise of innovative players capitalizing on these changes to deliver unique value propositions. Traditional insurance companies face significant challenges and opportunities as they navigate competition from established Big Tech firms and agile insurtech startups. This study examines the disruptive nature of digital advancements, compelling historical players to confront the innovator's dilemma: whether to adapt established practices or invest in new strategies to leverage digital opportunities. We highlight the necessity for insurance actors to rethink their roles in light of new market entrants and the evolving landscape shaped by Big Tech's data monetization strategies. To analyze these dynamics, we propose a novel framework in the form of a triangle of possibilities, which positions various market players and elucidates their strategic movements, innovations, and partnerships. This framework also aids in identifying competitive advantages and growth trajectories, ultimately offering scenarios for the evolution of traditional insurance players in a data-driven era.*

If you'd like to apply for an internship, PhD supervision, or postdoctoral fellowship, please send a short message, with an academic-style resume, and at least two names of references, willing to give feedback and recommendation, with their emails: charpentier.arthur@uqam.ca

k-nearest neighbors and k-means in Gini prametric spaces

by Cassandra Mussard (who worked with us on an internship last Summer, see Newsletter #2), Arthur Charpentier, and Stéphane Mussard, is now available doi:10.48550/arXiv.2501.18028.

> *This paper introduces innovative enhancements to the k-means and k-nearest neighbors (KNN) algorithms by leveraging the concept of Gini prametric spaces. Unlike traditional distance metrics, Gini prametrics incorporate both value-based and rank-based measures, offering robustness to noise and outliers. The paper's main contributions include (1) proposing a Gini prametric that captures rank information alongside value distances, (2) presenting a Gini k-means algorithm that is proven to converge and demonstrates resilience to noisy data, and (3) introducing a Gini KNN method that rivals state-of-the-art approaches like Hassanat's distance in noisy environments. Experimental evaluations on 14 datasets from the UCI repository reveal the superior performance and efficiency of Gini-based algorithms in clustering and classification tasks. This work opens new avenues for leveraging rank-based prametrics in machine learning and statistical analysis.*

Prametric spaces, introduced in Arkhangelskii & Pontryagin (1990), are topological spaces more general than metric spaces, requiring neither symmetry nor indistinction, nor the validity of the triangle inequality for "distance". They are endowed with a function d that must satisfy the non-negativity $d(x, y) \geqslant 0$ and $d(x, x) = 0$.

Arkhangelskii, A. & Pontryagin, L. (1990). *General Topology I*. Springer-Verlag, Berlin

The existence of gender bias through the use of algorithms in decision-making processes in liability and insurance law

(in French *L'existence de biais de genre par l'utilisation d'algorithmes dans les processus décisionnels en droit de la responsabilité et des assurances* by Rodolphe Bigot (Le Mans University) and Arthur Charpentier, as a chapter of *Genre, Algorithmes et Droit*, edited by Sophie Sereno and Emmanuelle Bonifay, (IBSN: 9782731413304).

> *1) What are the uses of automation and learning algorithms using gender-related data? What is at stake? What are the risks? - 2) Is the law adapted to combat any gender bias induced by the use of algorithms? If not, what changes are needed?*

Machine learning and economics

by Arthur Charpentier and Emmanuel Flachaire (Aix-Marseille Université), published in the *Revue d'Économie Politique*. This short article is an introduction to a special issue of the journal, doi.:10.3917/redp.346.0801.

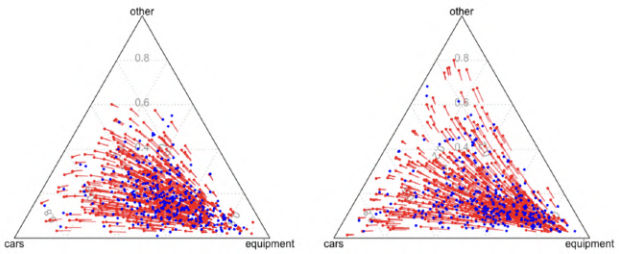
> *... These new datasets now enable economists to study individual and organizational behavior at unprecedented granularity and scale. They also highlighted the potential of massive data to uncover patterns and insights that traditional surveys or experiments might miss, while enabling real-time analysis. But beyond data, Charpentier, Flachaire & Ly (2018), and especially Agrawal, Gans & Goldfarb (2019), emphasized the evolution of models, and more specifically machine learning methods, which are transforming the way we analyze, predict and understand economic phenomena. Their ability to take into account complex relationships between variables often leads to the observation that these methods outperform conventional econometric methods in terms of predictions ...*

Optimal transport on compositional data for conterfactuals

by Agathe Fernandes-Machado, Ewen Gallic and Arthur Charpentier, is now available online doi:10.48550/arXiv.2501.15549.

> *Recently, optimal transport-based approaches have gained attention for deriving counterfactuals, e.g., to quantify algorithmic discrimination. However, in the general multivariate setting, these methods are often opaque and difficult to interpret. To address this, alternative methodologies have been proposed, using causal graphs combined with iterative quantile regressions (Plečko & Meinshausen (2020)) or sequential transport (Fernandes Machado et al. (2024)) to examine fairness at the individual level, often referred to as "counterfactual fairness." Despite these advancements, transporting categorical variables remains a significant challenge in practical applications with real datasets. In this paper, we propose a novel approach to address this issue. Our method involves (1) converting categorical variables into compositional data and (2) transporting these compositions within the probabilistic simplex of $\mathbb{R}^d$. We demonstrate the applicability and effectiveness of this approach through an illustration on real-world data, and discuss limitations.*

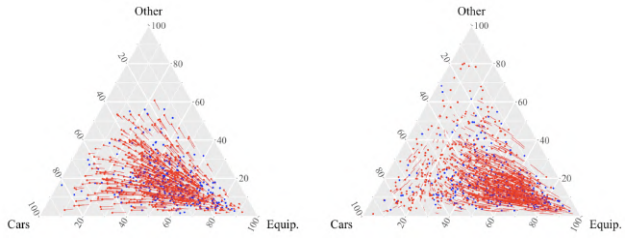
Plečko, D., & Meinshausen, N. (2020). Fair data adaptation with quantile preservation. *Journal of Machine Learning Research*, **21**, 1–44.



The codes used in the article are made available for reproducibility

https://github.com/fer-agathe/transport-s...

including a ggplot version of the plots



Functional central limit theorems for epidemic models with varying infectivity and waning immunity

by Arsène Brice Zotsa Ngoufack was published in ESAIM: P&S (Probability and Statistics), doi:10.1051/ps/2024015, journal of the Société de Mathématiques Appliquées et Industrielles (SMAI) and the CNRS, in France.

> *We study a stochastic, individual-based epidemic model in which infected individuals gradually become susceptible again after each infection (generalized SIS model). Epidemic dynamics are described by the mean infectivity and susceptibility processes in the population, as well as by the number of infected and susceptible/non-infected individuals. In Forien et al. (2022), a functional law of large numbers (FLLN) is proved as the population size goes to infinity, and asymptotic endemic behaviors are also studied. In this paper, we prove a functional central limit theorem (FCLT) for stochastic fluctuations in epidemic dynamics around the FLLN limit. The FCLT limit for aggregated infectivity and susceptibility processes is given by a system of stochastic nonlinear integral equations driven by a two-dimensional Gaussian process.*

This work was presented at the CIMAT conference, page 16.

Hoeffding decomposition of black-box models with dependent inputs

by Marouane Il Idrissi, Nicolas Bousquet (EDF R&D and Sorbonne Université), Fabrice Gamboa (Institut de Mathématiques de Toulouse), Bertrand Iooss (EDF R&D) and Jean-Michel Loubes (INRIA), doi:10.48550/arXiv.2310.06567.

> *The additive decomposition of arbitrary functions of random elements is paramount for global sensitivity analysis and, consequently, for the interpretation of black-box models. The seminal work of Hoeffding (1948) characterized the vertices of such a decomposition in the special case of mutually independent inputs. Going beyond the framework of independent inputs is an ongoing challenge in the literature. Existing solutions have so far required constraining assumptions or suffer from a lack of interpretability. In this paper, we generalize the Hoeffding decomposition for dependent inputs under very flexible conditions. To this end, we propose a new framework for dealing with dependencies, based on probability theory, functional analysis and combinatorics. It allows us to characterize two reasonable assumptions about the dependence structure of inputs: non-perfect functional dependence and non-degenerate stochastic dependence. We then show that any real-valued square-integrable function of random elements satisfying these two assumptions can be uniquely additively decomposed, and propose a characterization of vertices using oblique projections. We then introduce and discuss the theoretical properties and practical advantages of sensitivity indices derived from this decomposition. Finally, the decomposition is illustrated analytically on bivariate functions of binary inputs.*

Hoeffding, W. (1948). A Class of Statistics with Asymptotically Normal Distribution. *The Annals of Mathematical Statistics*, **19**, 293–325.

Wildfires in California and natural disaster insurance

by Arthur Charpentier and Laurence Barry, was published in the newspaper *Le Monde*, in French, in January.


Le Monde

DÉBATS · BANQUES / FINANCE / ASSURANCE

TRIBUNE

Laurence Barry
Actuaire

Arthur Charpentier
Mathématicien

Incendies à Los Angeles : « La situation actuelle menace non seulement le marché de l'assurance, mais aussi l'économie californienne, dans son ensemble »

La Californie mais aussi la France métropolitaine et Mayotte sont trois exemples qui mettent en avant à la fois la nécessité et l'insuffisance d'un système assurantiel le plus large possible expliquent, dans une tribune au « Monde », l'actuaire Laurence Barry et le mathématicien Arthur Charpentier.

Publié aujourd'hui à 13h00 | Lecture 4 min.

With Laurence Barry, and Molly James, the question of natural disasters, in relation to the fairness of France's coverage regime (based on "national solidarity") had been addressed. In this short article, Arthur and Laurence draw a parallel between the situation in California and that in France.

> *For the past week, California has been ravaged by devastating wildfires, fueled by high winds and wooden buildings that aggravate the spread of flames. Thousands of people have been evacuated. The aging electrical infrastructure seems to be one of the main sources of the fires. The situation is all the more critical as firefighting services are facing severe budget constraints, even forcing them to recruit inmates to intervene in the field. But these fires also shed a particular light on the tensions threatening catastrophe insurance, and echo discussions currently taking place at French and European level.*

Charpentier, A., Barry, L., & James, M. R. (2022). Insurance against natural catastrophes: balancing actuarial fairness and social solidarity. *The Geneva Papers on Risk and Insurance-Issues and Practice*, **47** (1), 50–78.

Le Monde is a leading French daily newspaper, founded in 1944, recognized for its rigorous coverage of national and international news. Published in print and digital form, it targets a varied readership with analyses, surveys and editorials on political, economic, social and cultural topics.

The article was picked up by the Italian magazine *Economy*, in **Incendi a Los Angeles: una minaccia per il mercato delle assicurazioni e l'economia della California**.

Moral maze: ethics and discrimination in machine learning

Arthur Charpentier and Marie-Pier Côté wrote a short article for *The Actuary*, inspired by the following definition: "**discrimination** *is the act, practice, or example of separating or distinguishing categorically rather than individually*," according to the dictionary. And this is exactly what actuaries do on a daily basis (see Schauer (2006)).

> *The interplay between fairness, discrimination and efficiency in insurance poses considerable challenges for actuaries and regulators. Traditional models have focused on efficiency, often to the detriment of ethical fairness, while modern machine learning methods amplify problems of bias and opacity. This article examines key concepts such as actuarial fairness, demographic parity, counterfactuals, calibration and selection bias, exploring their implications in the context of insurance pricing. It also highlights the philosophical and practical difficulties inherent in resolving discrimination, offering a route to better practice.*

The article is freely available on theactuary.


IN FOCUS

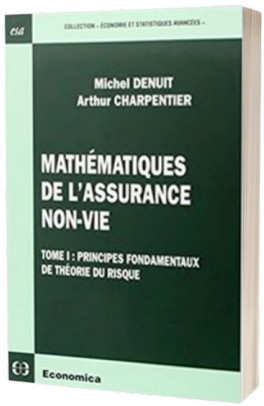
MORAL MAZE

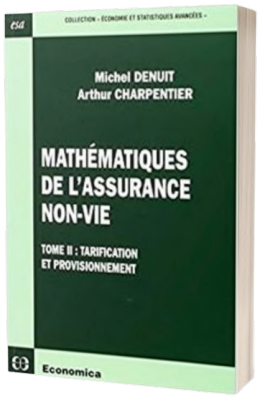
As machine learning comes to dominate modelling, how do we define and avoid inherent discrimination? Two Canadian academics discuss the complex ethics

The Actuary is a magazine published every two months by the Institute and Faculty of Actuaries, in the United Kingdom. The magazine covers news, features, and analysis on actuarial topics, including insurance, pensions, investments, and risk management.

Mathematics of Non-Life Insurance

A few years ago, Arthur Charpentier wrote with **Michel Denuit**, in French, the textbook **Mathematics of Non-Life Insurance**, in two volumes (1 and 2). Unfortunately, these popular manuals had been hard to obtain for some time. A new print run has been launched, and both volumes will soon be available in all good bookshops.





An online version in English is now available at nonlifemaths.github.io.

Can extreme risks be diversified?

by Arthur Charpentier, was published in *Risques*, 139, initially in French.

> *In a financial context, diversifying risks means investing in a variety of assets, sectors, or geographic regions to avoid having the poor performance of a single investment significantly affect the overall portfolio. Diversification allows for risk reduction, or, in its mathematical formulation, the reduction of variance. But what happens when we encounter large risks, infinite variance? Or worse, infinite expectation?*

A version in English is available on Arthur's blog


ÉTUDES ET DÉBATS | ARTHUR CHARPENTIER

Peut-on diversifier des risques extrêmes ?

Dans un contexte financier, diversifier les risques signifie investir dans une variété d'actifs, secteurs ou régions géographiques pour éviter que la mauvaise performance d'un investissement n'affecte trop l'ensemble du portefeuille. La diversification permet de réduire le risque, ou, dans sa formulation mathématique, de réduire la variance. Mais que se passe-t-il quand on est en présence de grands risques, de variance infinie ? Ou pire encore, d'espérance infinie ?

ARTHUR CHARPENTIER
Professeur,
Université du Québec à Montréal (UQAM)

Risques extrêmes, et espérance infinie ?

Formaliser des grandeurs en lien avec des quantités aléatoires et incertaines est un exercice compliqué. Les probabilités, au sens où le mot est souvent entendu, sont définies comme des limites de fréquences observées par répétitions d'événements. La probabilité d'avoir 3 en lançant un dé est ⅙ car en lançant un dé un million de fois[1], un milliard de fois, la probabilité sera aussi proche qu'on veut de ⅙. C'est ce que dit la loi des grands nombres, dans sa version la plus faible. Dire que la probabilité qu'il pleuvra aujourd'hui est de ¼ est totalement différent, car c'est un événement unique. Si je me fais tremper par une averse aujourd'hui, cela ne permettra aucunement de dire que la probabilité n'était pas, a priori, de ¼, et que le modèle météorologique s'est trompé. Tout ça pour rappeler que lorsqu'on fait de la modélisation, on va essayer d'imaginer les valeurs petites d'événements rares, et qu'il est malheureusement très difficile de les valider.

Et quand on modélise les grands risques, les très grands risques, il n'est pas rare d'avancer l'idée que les risques sont de variance ou d'espérance infinie. Or la notion d'espérance infinie est à la fois étrange, et probablement contre-intuitive[2]. Si on considère une variable aléatoire X positive (pour simplifier), et si on note $S(x)=\mathbb{P}(X>x)$ la fonction de survie, et $f(x)$ la densité (correspondant à l'opposée de la dérivée de S), on peut montrer que la moyenne empirique d'un million ou d'un milliard de tirages de cette variable va s'approcher autant qu'on veut d'une grandeur, appelée l'espérance mathématique.

$$E(X) = \int S(x)dx = \int x f(x)dx$$

Rien de bien étonnant ici : c'est encore la loi des grands nombres, énoncée dès 1713 par Jacob Bernoulli (le « golden theorem » de Raper (2018)) et surtout Pierre-Simon Laplace, en 1814. À condition toutefois que cette intégrale soit finie. Ce qui n'est pas garanti. Par exemple, la loi de Pareto d'indice α vérifie $S(x)=\mathbb{P}(X>x)=x^{-\alpha}$. Dès 1925, Karl-Gustaf Hagstroem avait noté que cette loi semblait particulièrement adaptée à la modélisation des grands risques, et donc en réassurance[3]. Et pour une variable qui suit une loi de Pareto d'indice 1, son espérance est, mathématiquement, infinie.

How to go beyond the coldness of numbers and take action?

by Arthur Charpentier and Nicolas Marescaux (Assistant director, Macif, in), published in *Risques*, 140, in French.

> *Today, our modern life relies largely on numbers. They guide most collective decisions and many individual choices. For Lord Kelvin, "If you cannot measure it, you cannot improve it." In other words, to make a good decision, you must first measure well. But is that enough? IPCC reports have been compiling data and figures for decades, announcing a short-term catastrophe. And yet, nothing happens.* "The modern man scorns imagination," ("le moderne dédaigne d'imaginer") *stated the French poet Stéphane Mallarmé in 1897. Isn't it this subjectivity of our imagination that could save us?*

A version in English is available on Arthur's blog

ÉTUDES ET DÉBATS | ARTHUR CHARPENTIER NICOLAS MARESCAUX

Comment dépasser la froideur des chiffres, et agir ?

ARTHUR CHARPENTIER
Professeur, Université du Québec à Montréal (UQAM)

NICOLAS MARESCAUX
Directeur adjoint, Réponses besoins sociétaires et innovation, Macif

Notre vie moderne repose en grande partie sur les chiffres. Ils orientent la plupart des décisions collectives et de nombreux choix individuels. Pour Lord Kelvin[1], « Ce qui ne peut être mesuré ne peut être amélioré. » Autrement dit, pour bien décider, il faudrait d'abord bien mesurer. Mais est-ce suffisant ? Les rapports du GIEC compilent des données et des chiffres annonçant, depuis plusieurs décennies, une catastrophe à court terme. Et pourtant, rien ne se passe. « Le moderne dédaigne d'imaginer » affirmait Mallarmé en 1897. Cette subjectivité de notre imaginaire ne pourrait-elle pas nous sauver ?

112

Discounting the future?

by Béatrice Cherrier (CNRS researcher at ENSAE-Institut Polytechnique, in) and Arthur Charpentier, published in *Risques*, 141. Find an English version on Arthur's blog

> *The first lessons in insurance and financial mathematics address discounting and the value of time, borrowing Christian Gollier's expression, because insurers must account for this temporal aspect in medium-term annuity calculations. But do these discounting calculations, used for centuries to reflect individual decisions (of policyholders, investors, companies), still make sense when used to guide public policy decisions with long-term consequences, like climate policies? When Kenneth Arrow joined the IPCC team in 1993, he expressed this concern to the coordinator of certain chapters: discounting in climate economics is as necessary as it is controversial.*

ÉTUDES ET DÉBATS | ARTHUR CHARPENTIER BÉATRICE CHERRIER

Comment escompter le futur ?

ARTHUR CHARPENTIER
Professeur, Université du Québec à Montréal (UQAM)

BÉATRICE CHERRIER
Directrice de recherche, CNRS-ENSAE/CREST

Cet article présente l'historique de l'utilisation des calculs d'actualisation dans les modèles d'aide à la décision publique. Plébiscités, un temps, par les économistes, ces modèles sont-ils vraiment adaptés, notamment au domaine de l'économie climatique qui doit se projeter à cent cinquante ou mille ans ? Explications et pistes de réflexion sur cette théorie de l'actualisation.

Les premiers cours d'assurance et de mathématiques financières parlent de l'actualisation et de la valeur du temps, pour reprendre l'expression de Christian Gollier, car les assureurs ont besoin de tenir compte de cet aspect temporel dans les calculs de rentes, à moyen terme. Mais ces calculs d'actualisation, utilisés depuis des siècles pour rendre compte de décisions individuelles (d'assurés, d'investisseurs, d'entreprises) ont-ils encore du sens quand ils sont utilisés pour éclairer ces choix de politiques publiques dont les conséquences se font sentir sur le long terme, comme les politiques climatiques ? Kenneth Arrow, lorsqu'il rejoint l'équipe du GIEC en 1993, s'en était déjà ouvert au coordinateur de certains chapitres : l'escompte en économie du climat est aussi nécessaire que controversée : « Votre plan est très complet, à une exception près. Une discussion sur les taux d'actualisation s'impose. Dans une large mesure, les politiques proposées impliquent des coûts actuels (réduction de la consommation de carbone) pour éviter des désutilités et des coûts futurs. Il est évident que l'arbitrage entre le présent et l'avenir est crucial, même s'il est controversé », écrivait-il (Cherrier et Duarte 2024). L'histoire de ce transfert d'un outil mathématique individuel à une dimension collective depuis les années 1930, que nous résumons ici, est riche d'enseignements.

Mathématique du comportement individuel : petite histoire de l'escompte exponentiel

Pour rappel, la théorie de l'actualisation (on pourra aussi parler d'escompte, traduction plus littérale du terme anglais « discount ») découle d'une hypothèse assez simple : le taux de variation de la valeur d'un bien doit être proportionnel à la valeur actuelle, autrement dit, $y'r\text{-}y$. Cette équation différentielle a une solution assez simple, de la forme $y(t)y(0)\exp(rt)$. En fait, c'est la définition même de la fonction exponentielle : la seule fonction qui soit proportionnelle à sa dérivée. C'est le « problème de Cauchy », proposé par Augustin Louis, baron Cauchy, né en 1789. Cette solution présente l'avantage d'offrir une forme de cohérence temporelle, puisque $y(s+t)y(s)\exp(rt)y(t)\exp(rs)$. Cette formulation en

88

A comment on the proposed automobile insurance rating and underwriting supervision guidance

Arthur Charpentier, Marie-Pier Côté, Olivier Côté and Agathe Fernandes Machado wrote a short note to the Financial Services Regulatory Authority of Ontario (FSRA) on their "Proposed Automobile Insurance Rating and Underwriting Supervision Guidance"

> *The principles of "No unfair discrimination", "No unfair bias" and "No proxies" are at the heart of the FCO fairness objectives. However, their definitions seem to overlap and lack clarity on how they differ in purpose and application. Fairness is complex, with persistent ambiguity and practical challenges. Practitioners often hesitate to act due to a limited understanding of what is really important in these concepts. We recommend refining these three principles to reduce overlap, clarify key aspects and define the distinct role of each principle.* (···) *The FCO tests mentioned seem to focus on population-level metrics, which may overlook the minority-centric nature of fairness. Even when sensitive attributes are clearly defined and observed in the data, fairness requires protecting the most vulnerable subpopulations within these groups — often minorities among minorities. Practitioners need tests that target what's really important, are easy to interpret, directly applicable and clearly aligned with the FCO's broader fairness principles.*

As mentioned below (with the presentation for the Financial Conduct Authority, FCA, London, UK, in November, page 18), we are now striving to provide more and more advice to regulators, on the context of fairness and discrimination issues, in insurance markets.

Interviews

- Arthur Charpentier gave an interview, "Actuarial ethics and the future of the profession" to Jennifer Baker, for **The European Actuary**, volume 40,

> *... In Europe everything is done for the good of consumers. But sometimes being good for consumers in insurance is to go against the common good. It's not possible to say to policyholders "it will be good for you" because usually if it's good for you, it will be bad for someone else. We have this problem in insurance, which is sort of a zero sum game...*

The European Actuary was founded in 2010 as a collaboration of the Faculty of Actuaries (Great Britain), Actuarieel Genootschap & Actuarieel Instituut (Netherlands), Institut des Actuaires (France) and Deutsche Aktuarvereinigung (Germany).

Since 2016 the magazine is published by the Actuarial Association of Europe (AAE).

- Parts of the previous interviews were used in an article published in **Euractiv**, "Europe's green future needs more private investment, urgently", by Jennifer Baker,

> *... Fortunately, the financial sector, including private fairness and venture capital, is increasingly recognizing the importance of climate-related investments. Many firms are now integrating environmental factors into their investment decisions and risk management processes. This shift is driven by both the need to mitigate climate risks and the opportunities presented by the transition to a greener economy, explained risk expert Arthur Charpentier, fellow of the French Institute of Actuaries...*

L'ACTUARIEL

- Arthur Charpentier was interviewed on the subject of Financial Data Access (FIDA) regulation, in Europe, which served as the basis for the article "**Open finance: Big bang announced in insurance**" by Séverine Leboucher, and published in *L'Actuariel*,

L'Actuariel is published by the Société des Actuaires, in France, since 2011.

> *The debate is being framed in a devious way, by making people believe that they will benefit from more personalized products, without remembering that insurance is often a zero-sum game, and that if some people pay less, it means that others pay more," says Arthur Charpentier, professor at the Université du Québec à Montréal and Fellow actuary.*

- An article of the magazine *Urbania*, in Québec, mentioned recent work by Arthur Charpentier on predictive markets.

Conference Organization

Montréal - Guanajuato Workshop on Probability and Machine Learning

photo credit: Yuko Nishikawa.

Yuko Nishikawa is a Brooklyn-based multidisciplinary Japanese artist and designer, known for her organic, dreamlike works. She grew up in the seaside town of Chigasaki, south of Tokyo. Thanks to Yuko for allowing us to use a photo of one of her works for the workshop.

YUKO NISHIKAWA

probabilitymachinelearning.eventos.cimat.mx

with Arturo Jaramillo Gil (CIMAT), Saraí Hernández-Torres (UNAM), Emilien Joly (CIMAT), Sandra Palau (UNAM), Courtney Paquette (McGill), Elliot Paquette (McGill), José Luis Pérez (CIMAT), James Melbourne (CIMAT) and Jean-François Renaud (UQAM).

Arsène Brice Zotsa Ngoufack and Marouane Il-Idrissi were invited to present recent work.

The **Centro de Investigación en Matemáticas** (**CIMAT**), located in Guanajuato, Mexico, is a leading research institution specializing in mathematics, statistics, and computer science. As part of Mexico's National System of Public Research Centers (**CONACYT**), CIMAT excels in both theoretical and applied research, fostering innovation and addressing complex real-world problems. This dynamic academic environment supports advanced studies, offering master's and doctoral programs while promoting interdisciplinary collaboration. Situated in the picturesque city of Guanajuato, a UNESCO World Heritage site, CIMAT attracts researchers and students from around the world, making significant contributions to scientific and technological advancements in Mexico and beyond.

The first objective of the workshop was to bring together researchers and academics from Québec and Mexico in the fields of probability theory and machine learning. By emphasizing both theoretical foundations and practical applications, the conference showcased research conducted by speakers representing various career stages in academia. This facilitated the exchange of ideas and opened opportunities for new collaborations.

The second objective was to encourage and promote student mobility between Mexico and Québec. The workshop included short presentations by master's students, PhD candidates, and postdoctoral researchers, providing them with the opportunity to present their work and engage with different researchers. This allowed them to expand their academic network and could open future mobility opportunities for them.

In this regard, **Dante Mata López** (alumni: BSc UNAM, MSc University of Bath, PhD CIMAT Guanajuato) is currently sharing an office with the team, as a postdoctoral fellow. This summer, two interns will be joining the team: **Allison Lara Nieva**, from the Universidad Nacional Autónoma de México (Agathe Fernandes Machado will be involved in the supervision) and **Fabián Domínguez López**, from the Universidad de Guanajuato, working with Hélène Guérin (Arsène Brice Zotsa Ngoufack will be involved in the supervision).

Conference Presentations

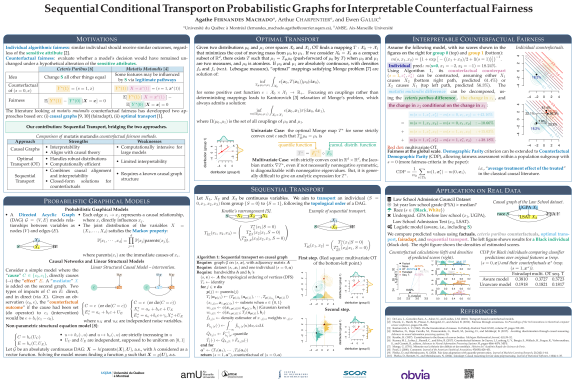
We have participated in several conferences and seminars over the past six months. In particular, this winter, Agathe Fernandes Machado attended the NeurIPS (Neural Information Processing Systems) conference in Vancouver and the AAAI (Association for the Advancement of Artificial Intelligence) conference in Philadelphia, which are among the top conferences in computer science (according to Google Scholar ↗). Both conferences are rated A* according to the CORE ranking ↗.

NeurIPS, Vancouver, Canada

Mid-December, Agathe Fernandes Machado presented Post-Calibration Techniques: Balancing Calibration and Score Distribution Alignment, at the Neural Information Processing Systems conference (commonly known as **NeurIPS**), during the **workshop on Bayesian Decision-making and Uncertainty**, in Vancouver, Canada 🌐.

AAAI, Philadelphie, United States of American

In February, Agathe participated in the 39th annual conference of the **Association for the Advancement of Artificial Intelligence (AAAI)** 🌐, in Philadelphia (Pennsylvania), to present a paper co-authored with Arthur Charpentier and Ewen Gallic, Sequential Conditional Transport on Probabilistic Graphs for Interpretable Counterfactual Fairness (featured in Newsletter #2 ↗).



https://fer-agathe.github.io/sequential_trans...

A detailed notebook with R code is available, containing simulated examples as well as an application to the adult dataset, R.

Last year, François Hu attended the 38th Conference in Vancouver, Canada, to present some work on Wasserstein barycenters (Newsletter #1 ↗).

Financial Conduct Authority (FCA) Seminar, London, United Kingdom

Early November, Arthur Charpentier was invited to give a talk titled Demystify fairness and discrimination in insurance, and avoid some pitfalls, at the seminar of the **Financial Conduct Authority (FCA)** in London, United Kingdom.

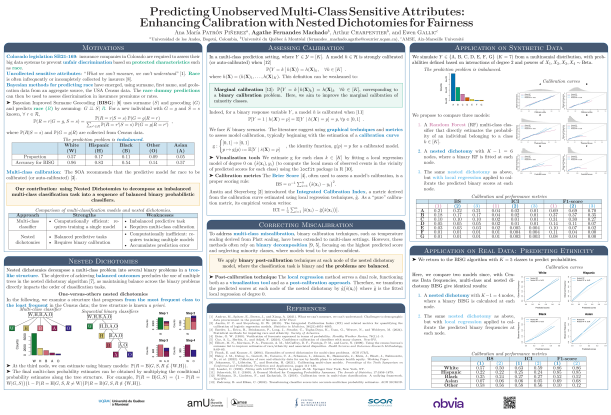
> *What is unique in the field of insurance is that even statistical discrimination, which by definition is devoid of malicious intent, poses significant challenges. On one hand, policymakers would like insurers to treat their insured fairly, without discrimination based on race, gender, age, or other characteristics, even if it may make sense (statistically) to discriminate (indirectly). On the other hand, at the heart of actuaries' activities lies discrimination between at-risk and non-at-risk insured individuals. And this risk is often statistically correlated with sensitive characteristics that regulations would like to prohibit insurers from considering.* The analysis of possible discriminations in decision rules, whether human or algorithmic, is an old subject. Most concepts date back at least to the 1950s, but recent developments in artificial intelligence have brought these questions to the forefront. Big data facilitates statistical or proxy discrimination, and black-box algorithms do not aid understanding.

Actuarial and Financial Mathematics Conference, Bruxelles, Belgium

Marie-Pier Côté presented the paper Selection bias in insurance: why portfolio-specific fairness fails to extend market-wide (page 6) at the **Actuarial and Financial Mathematics Conference: Interplay between Finance and Insurance**, held in Brussels, Belgium. Agathe Fernandes Machado also attended the conference and presented Predicting Unobserved Multi-Class Sensitive Attributes: Enhancing Calibration with Nested Dichotomies for Fairness. The article will be available soon.

(from left to right, Marie-Pier Côté (professor at Université Laval), Agathe Fernandes Machado (PhD student) and Fei Huang (professor at UNSW, Newsletter #2))

This prestigious conference has been held annually in Belgium since 2003. Arthur Charpentier participated (among the *contributed talks*) in 2008 to discuss Pricing catastrophe options, and in 2020 (just before the first COVID19 lockdown) as a keynote speaker, to talk about Insurance Pricing in a Competitive Market (which we will discuss in the next newsletter).



Seminars et conferences (others)

- Marie-Pier Côté presented Selection bias in insurance: why portfolio-specific fairness fails to extend market-wide at **HEC Montréal**,
- Arthur Charpentier was invited to give a talk on AI, biaises and fairness for insurance to the students of the **Association des Masters d'Actuariat**, en France (online,),
- Marouane Il-Idrissi gave a talk on Generalized Hoeffding Decomposition and the (surprising) linear nature of non-linearities at the **CRM-ISM Montréal Probability Seminar**, at the University McGill,
- Ewen Gallic was plenary speaker at the **SUMM 2025**, the **séminaires universitaires en mathématiques à Montréal**, to talk on Optimal transport optimal for algorithmic fairness, in front of a hundred graduate students,
- Arthur gave a talk at the **CIMAT Colloquium** in Guanajuato, Mexico on Optimal transport for algorithmic fairness,

- Arthur was invited for a couple of days at the **University of Toronto**, where he gave a talk on Optimal transport for counterfactual and group fairness in predictive modeling,
- Mulah Moriah presented Measuring and mitigating biases in motor insurance pricing (Newsletter #2 ↱) at the **online presentation of new EAJ issues** (European Actuarial Journal).

- Oliver Côté gave a talk on Causal perspective on direct and indirect discrimination linked to sensitive characteristics in insurance predictive models at the **Séminaire étudiant de l'IID** 🌐, on *Modèles causaux et inférence causale en médecine et assurance*, in October,
- Arthur was invited speaker at the **39ème Annual Meeting of the Canadian Econometrics Study Group** (CESG 🌐), in Toronto, on October 2024, to give a talk on Calibration of Probabilistic Scores of Classifiers,
- Marouane gave a talk entitled Sobol' indices, Shapley effects and a new path towards handling dependent inputs to the **sensitivity analysis community**, on Discord, online ▶,
- Marouane gave a talk on Hoeffding's functional decomposition for dependent inputs at the **Conference on New Developments in Probability**, at the Université de Montréal 🌐,
- Olivier gave a talk on Beyond Numbers: The Actuary's Role In Fair Financial Decision at the monthly webinar series of the **Actuarial Students' National Association** (ASNA) 🌐,
- Samuel Stocksieker (former PhD student, Newsletter #2 ↱) gave a talk entitled Data Augmentation with Variational Autoencoder for Imbalanced Dataset, at the **31st International Conference on Neural Information Processing** (ICONIP'24) that was organized in Auckland, New-Zeland (online),
- Marouane gave a talk Robustness assessment of black-box models to feature perturbations at the **Workshop on Probability and Machine Learning** organized at CIMAT, 🌐, in Guanajuato, Mexico, mentioned abovem page 16. Arsène Brice Zotsa Ngoufack presented Generalised SIS non-Markovian model with waning immunity at the same conference,
- Agathe Fernandes Machado presented recent work, with François Hu, Score de mortalité, analyse de la discrimination at the **Milliman R&D Seminar**, in Paris
- François Hu presented A Sequentially Fair Mechanism for Multiple Sensitive Attributes (Newsletters #1 ↱) at the **L^P Lyon-Lausanne-Paris Actuarial Seminar** (CNAM-ISFA-HEC Lausanne)
- Ewen gave a talk Algorithmic Fairness Through Counterfactual Analysis and Optimal Transport during a one-day workshop at the **IRL (International Research Lab)–CNRS** of Montréal,
- Samuel presented recent work on Données Déséquilibrés en Assurance at the **Laboratoire de Sciences Actuarielle et Financière Seminar** at the **Institut de Science Financière et d'Assurances** (ISFA) in Lyon, in France,
- Agathe participated at the one-day workshop at the **Institut du Risque et de l'Assurance (IRA)**, in Le Mans, in France (13ème séminaire actuariat-finance IRA-ISFA ENSAE) 🌐, where she met up with Fallou Niakh (Newsletters #1 ↱)
- Agathe gave a talk on Calibration of predictive models at the **EDF R&D Seminar**, in Paris 🌐,
- Marie-Pier gave a talk on A Fair price to pay: exploiting causal graphs for fairness in insurance at the seminars of the **ULB** (université Libre de Bruxelles) in February, and **UCLouvain** (université Catholique de Louvain) in March, while visiting KUL (Leuven) for a few weeks,
- Arthur was invited to give a talk on Algorithmic fairness with optimal transport quantifying counterfactual fairness and mitigating group fairness, at the **CRM-Statlab Day**, in Québec city, in octobre 🌐.

Forthcoming

- Four summer interns will arrive, soon, with **Allison Lara Nieva**, from the Universidad Nacional Autónoma de México (UNAM), **Lucas Offroy** double degree from INSA Rennes and EURIA, in France, **Iryna Voitsitska** (Ірина Войціцька) from the Ukrainian Catholic University, (Український Католицький Університет) à Lviv (Львів), and **Mahery Andriamadison** from Sorbonne Université in Paris. Thanks Agathe, Marouane, Brice and Ewen, who were in charge of the interviews,
- Marouane was invited to present recent work at the **11th International Conference on Sensitivity Analysis of Model Output, SAMO**, in France,
- Agathe will be at the **Isaac Newton Institute for Mathematical Sciences** in **Cambridge**, U.K., in June, for a week, where a conference on calibration is organized,
- Arthur will give a series of talks, at the **Bermuda Monetary Authority**, at the actuarial seminar of **HEC Lausanne-UNIL** in Switzerland, the annual meeting of actuaries in Luxembourg, **ILAC**, and this summer, will participate at the **Actuarial Research Conference**, at York University (in Toronto, Ontario).
- Arthur will also give a seminar at the **SCOR Foundation for Science** webinar, mi-June, on machine learning and econometrics.
- A one-day workshop **Confidence and Fairness: Scientific Foundations in AI and Risk** will be organized in Paris by Arthur Charpentier and **Antoine Ly** at the SCOR headquarters.

There is a clear and increasing interest in the ethical and societal implications of machine learning and artificial intelligence (AI) in the insurance industry, but also outside. The goal of this workshop is to discuss:

- Algorithmic Fairness and Bias Mitigation: Developing methods to ensure that AI systems operate without bias, providing fair outcomes across diverse populations.
- Ethics of AI and Machine Learning: Exploring the moral principles guiding the development and deployment of AI technologies, ensuring they align with societal values and human rights.
- Transparency and Accountability in AI Systems: Advocating for clear and understandable AI decision-making processes to build trust and allow for effective oversight.
- Regulatory and Policy Implications of AI: Analyzing how laws and regulations can keep pace with AI advancements to protect individuals and society, including discussions on industry standards and the role of governance in ensuring fair AI practices.
- Human Rights and AI: Investigating how AI impacts fundamental human rights, such as privacy, equality, and non-discrimination, and proposing frameworks to safeguard these rights in the age of AI.

In line with our “Research Policy” (described in Newsletter #2), invited speakers will come from Europe (U.K., Belgium, Germany, Italy).

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