Insurance: bias, discrimination & fairness

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Brief overview

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Actuarial Science and Economics of Insurance
Algorithms and Statistical Learning
Dynamic Games and Market Equilibrium

Insurance: Discrimination, Biases and Fairness *ILB*  
Assurance: Discrimination, Biais et Équité *ILB*
Brief overview

- ILB (Institut Louis Bachelier) publications
- AXA Joint Research Initiative on Unusual Data for Insurance
  see Grari et al. (2022)
- COVEA (Chair 2015-2018 & Fair IA 2023)
- ACPR (Autorité de Contrôle et de Régulation)

- Students MSc & PhD working on fairness, causal inference & interpretability
- Academics invitations for short-term visits 2022-2023
- KPMG joint projects
Brief overview

Workshop on fairness and discrimination in insurance, May 13, Québec City

https://iid.ulaval.ca/jeda2022
Agenda & keywords

“Technology is neither good nor bad; nor is it neutral”, Kranzberg (1986)

- Insurance, mutualization, solidarity vs. individualization, heterogeneity
- Discrimination, actuarial fairness, legal aspects, discrimination by proxy
- Biases observation vs. experiment, selection bias, omitted variable bias
- Fairness, $\hat{Y} \perp P$, $\hat{Y} \perp P | Y$ or $Y \perp P | \hat{Y}$, and individual fairness (counterfactual)
- Explainability and interpretability

see Charpentier (2022), Barry and Charpentier (2022) and Grari et al. (2022) for further details
Insurance, risk pooling & solidarity

- policyholder
- insurer

premium

indemnity
Insurance, risk pooling & solidarity

- Insurance is the contribution of the many to the misfortune of the few
Insurance, risk pooling & solidarity

- Insurance is the contribution of the many to the misfortune of the few
Heterogenous Risks I

- Claim frequency, as a function of the age of the driver (data Charpentier (2014))

- “actuaries smoothed because smoothing was a ‘mathematical and ethical’ good”, Bouk (2015)

- interpretability and explanability, “young drivers are more likely to have an accident”
Heterogenous Risks II

- Life insurance, life tables function of the age and the gender
- Men / women table, 1720 (Struyck (1912), page 231)

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<th>Men</th>
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Insurance and premium “individualization” I

“*It is important to distinguish two things when talking about insurance. The first, the insurance operation, is technical and has a collective dimension, the second, the insurance contract, is legal and has an individual dimension*,” Bigot and Cayol (2020) (aussi Thiery and Van Schoubroeck (2006), Lehtonen and Liukko (2015))

**Individualistic approach**

- The individualistic approach to equality analyses fundamental rights, such as the right to equal treatment, in terms of individuals.
- An individual cannot be treated differently because of his or her membership in such a group, particularly in a group to which he or she has not chosen to belong.

**Group approach**

- The insurance tradition, on the other hand, analyses risks, premiums and benefit schedules in terms of groups.
- Unlike the individualistic approach, insurance classification schemes rely on the assumption that individuals answer to the average (stereotypical) characteristics of a group to which they belong.
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Bureau d’Assurance du Canada (2021)
Legal Perspective II

In Québec province

▶ “Toute personne a droit à la reconnaissance et à l’exercice, en pleine égalité, des droits et libertés de la personne, sans distinction, exclusion ou préférence fondée sur la race, la couleur, le sexe, l’identité ou l’expression de genre, la grossesse, l’orientation sexuelle, l’état civil, l’âge sauf dans la mesure prévue par la loi, la religion, les convictions politiques, la langue, l’origine ethnique ou nationale, la condition sociale, le handicap ou l’utilisation d’un moyen pour pallier ce handicap.” (C-12 - Charte des droits et libertés de la personne, art. 10)

▶ “la distinction fondée sur l’âge, le sexe ou l’état civil est permise lorsqu’elle repose sur un facteur qui permet de déterminer un risque. Par exemple, une compagnie d’assurance peut vous poser des questions sur votre âge et votre sexe pour fixer votre prime” (art. 20.1)
Proxy Based Discrimination (?) I

- **location** (policyholder home address)

Jean et al. (2016), Seresinhe et al. (2017), Gebru et al. (2017), Law et al. (2019), Ilic et al. (2019), Kita and Kidziński (2019), see also redlining
Proxy Based Discrimination (?) II

▶ credit scoring,


source https://www.incharge.org/debt-relief/credit-counseling/
Biases in Data Generation

- historical bias
- sampling bias
- dataset
  - training sample
  - validation sample
  - (testing)
- sample
- measure bias

(inspired by Suresh and Guttag (2019)).
Biases in Modeling

(-inspired by Suresh and Guttag (2019)).
Measuring and quantifying equity

Notations:

\[
\begin{align*}
  y \in \{0, 1\} & \quad \text{variable of interest} \\
  p \in \{0, 1\} & \quad \text{protected variable (sensitive)} \\
  x \in \mathbb{R}^d & \quad \text{‘explanatory’ variables} \\
  s \in [0, 1] & \quad \text{score, classically } s = s(x, p) \\
  \hat{y} \in \{0, 1\} & \quad \text{classifier, classically } \hat{y} = 1(s > t)
\end{align*}
\]

**Fairness Through Unawareness**, Kusner et al. (2017)

Protected attribute \( p \) is not explicitly used in decision function \( \hat{y} \).
<table>
<thead>
<tr>
<th><strong>Measuring and quantifying equity II</strong></th>
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<tbody>
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<td><strong>statistical parity</strong></td>
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<td><strong>conditional statistical parity</strong></td>
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<td><strong>equalized odds</strong></td>
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<td><strong>equalized opportunity</strong></td>
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<td><strong>predictive equality</strong></td>
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<td><strong>balance (positive)</strong></td>
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<td><strong>balance (negative)</strong></td>
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<td><strong>conditional accuracy equality</strong></td>
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<td><strong>predictive parity</strong></td>
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<td><strong>calibration</strong></td>
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<td><strong>well-calibration</strong></td>
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<td><strong>accuracy equality</strong></td>
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<td><strong>treatment equality</strong></td>
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</tbody>
</table>
Lipschitz property, Duivesteijn and Feelders (2008)

\[ D(\hat{y}_i, \hat{y}_j) \text{ ou } D(s_i, s_j) \leq d(x_i, x_j), \forall i, j = 1, \ldots, n. \]

Cf formal intervention “\( X \) is fixed at \( x \)”, see “\( do(X = x) \)” in Pearl (1998) (or simply \( do(x) \)), (historically, from Wright (1921), Neyman et al. (1923) or Rubin (1974), Holland (1986))

Conterfactual fairness, Kusner et al. (2017) If the prediction in the real world is the same as the prediction in the counterfactual world where the individual would have belonged to a different demographic group, we have counterfactual equity, i.e.

\[ P[Y^*_P \leftarrow p = y|X = x, P = p] = P[Y^*_P \leftarrow p' = y|X = x, P = p], \forall p', x, y. \]
To go further on quantifying fairness

- \( P \) must be collected
- Looking for counterfactual
- DAGs are important


References IV


References V


