CSE 5249 Project

Causal FairSum: Fairness Summarization through Distributed Causal Explanations

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Motivation

1. Aggregate data views of databases hold valuable information about **relationships between attributes**.
   Finding **causal** relationships can help in data fairness evaluation beyond simple correlations.
2. Databases can get **very large**, especially ones hosted on cloud services (e.g. AWS, Google Cloud); fairness evaluation on the **entire dataset at once is unviable**.
   Common practice is to partition the database for **privacy** & distributing **computation costs**.

CauSumX

CauSumX[1] is a recent algorithm enabling generation of causal explanations for aggregate data views.

1. **Mine frequent grouping patterns** using the seminal **Apriori** algorithm.
2. Use a greedy lattice-based algorithm for **mining promising treatment patterns** for each grouping pattern.
3. Model the optimization problem as an Integer Linear Program (ILP) to find explanation patterns that **maximize "explainability."**

Problem Statement

We proposed an **extension to CauSumX** that **analyzes causal relationships** between attributes in a **distributed setting**, to reveal **causal explanations** for any potential biases discovered.

Relevance to **CSE 5249**

- Causal Reasoning helps address questions about **effects of hypothetical interventions.**
- Group Fairness and **demographic parity** for quantifying arguments about data biases.
- Bias Discovery: reveal underlying **social biases & wrongful discrimination** based on study of their manifestation in gathered data.

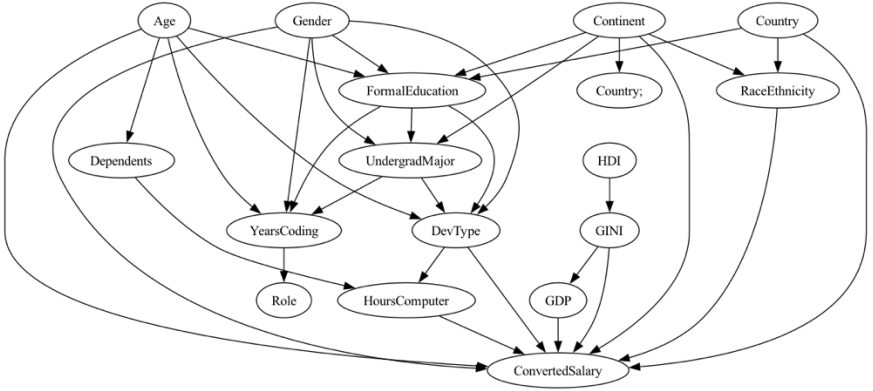
Method

1. Extend CauSumX to evaluate causality in a **distributed setting**.
2. Independently run CauSumX for **different subsets** of the data (simulating a distributed setting), conditioning on predetermined **sensitive attributes**.
3. Compare the **subgroup causal explanations** to uncover fairness insights and biases across groups.

Datasets

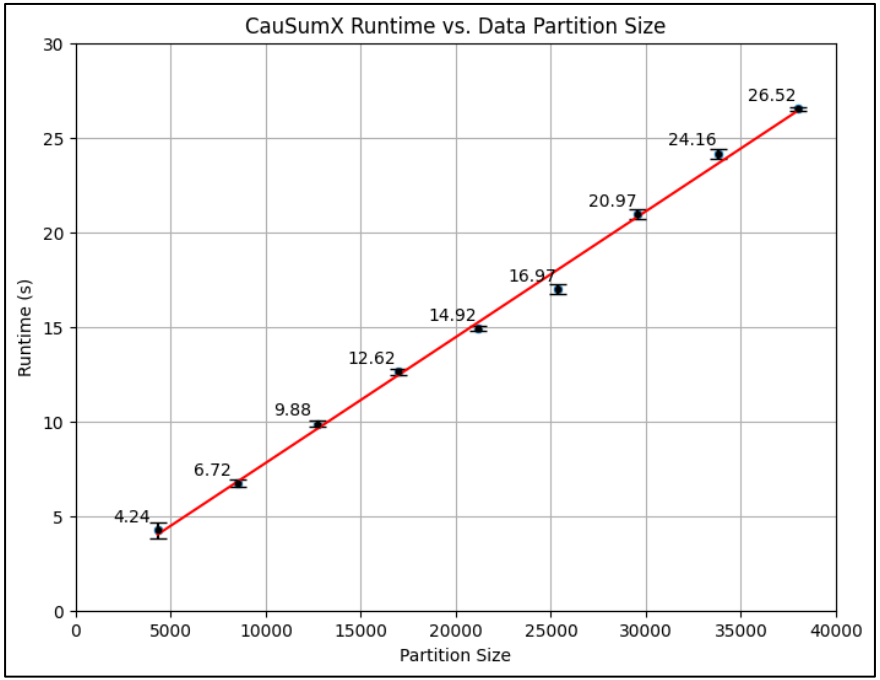
We utilize the same datasets and Causal DAGs as the original CauSumX paper including:

- StackOverflow
- UCI German Credit
- UCI Adult



Results

1. Extended CauSumX to evaluate causality in a **distributed setting,** validated by partitioning the datasets.
2. Integrated **Localized Approximated Miner (LAM)** algorithm to identify grouping patterns (in lieu of the Apriori algorithm)
3. **Comparing LAM and Apriori** frequent itemset mining algorithms – LAM finds longer patterns with higher explainability at the cost of minor coverage losses,
4. **Achieved higher explainability scores** for Adult & German datasets compared to original work.*



Next Steps

1. Explore methods of **combining explanation patterns**
   - Ex. Add explainability scores across partitions.
2. **Compare the subgroup causal explanations** to uncover fairness insights and biases across groups.
3. Automate **DAG-discovery process.**
   - Current methods do not allow for DAG-discovery with categorical data fields.

References

[1] Brit Youngmann, Michael Cafarella, Amir Gilad, and Sudeepa Roy. 2024. *Summarized Causal Explanations For Aggregate Views.* Proc. ACM Manag. Data 2, 1 (SIGMOD), Article 71 (February 2024), 27 pages. https://doi.org/10.1145/3639328

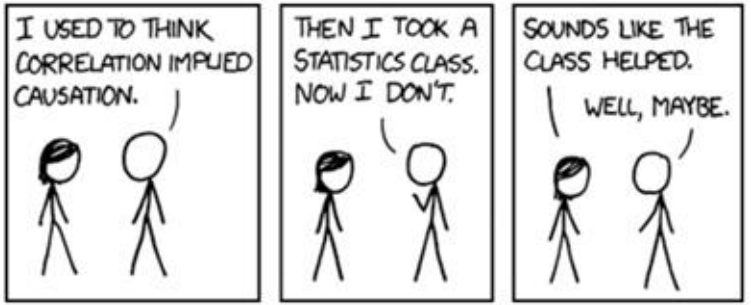
[2] Bareinboim, E., & Plečko, D. (n.d.). *Causal fairness analysis.* https://fairness.causalai.net/

[3] G. Buehrer, R. L. de Oliveira, D. Fuhry and S. Parthasarathy. 2015. *Towards a parameter-free and parallel itemset mining algorithm in linearithmic time*. IEEE 31st International Conference on Data Engineering, pp. 1071-1082 https://ieeexplore.ieee.org/document/7113357

[4] Traag, V. A., & Waltman, L. 2022. *Causal foundations of bias, disparity and fairness.* https://arxiv.org/abs/2207.13665

[5] Rakesh Agrawal and Ramakrishnan Srikant. *Fast algorithms for mining association rules*. VLDB September 1994. https://www.vldb.org/conf/1994/P487.PDF

Questions?


I USED TO THINK CORRELATION IMPLIED CAUSATION.
THEN I TOOK A STATISTICS CLASS. NOW I DON'T.
SOUNDS LIKE THE CLASS HELPED.
WELL, MAYBE.