1 Introduction

Proper experimentation guarantees internal validity, that is, causal conclusions obtained from it hold true for the domain from where the sample was drawn. However, most experimental findings are intended to be generalized to a broader, or even different, target domain (in other words, population, setting, or environment).

2 Motivating Example

[Greenhouse et al. 2008]

- The FDA performed randomized controlled trials to assess the effect of antidepressant drugs on suicide risk.
  
  \[
  P(Y = 1 | \text{do}(x)) > P(Y = 1 | \text{do}(x))
  \]

- Results led to the addition of a strict warning to the drug’s label.
  
  Surprisingly, following the warning, a decrease in prescriptions was reported together with an increase of suicidal events in the corresponding age group.
  
  \[
  P(Y = 1 | \text{do}(x)) < P(Y = 1 | \text{do}(x))
  \]

- Several observational studies reported positive results for patients using the same antidepressants, even after accounting for access to mental health-care and other confounding factors.

3 Challenges

1. Transportability

There is a mismatch between the study population π and the general clinical population π* regarding ethnicity, race, and income (covariates named E).

2. Selection Bias

FDA’s studies sampled from a distinct population by excluding youths with elevated baseline risk for suicide (B) from their cohorts.

4 st-Adjustment

**Strategy.** Recalibrate the observed effect of the treatment on the outcome in the studied population using observations from the target population.

\[
P^*(y | \text{do}(x)) = \sum P(y | \text{do}(x), z, S = 1) P^*(z)
\]

**Unbiased target effect in π***

Given a candidate set Z, special attention needs to be paid to those affected by the treatment that are correlated with the outcome given pre-treatment covariates. Call them Zπ.

5 Task(s) Overview

1. Given a set Z, does the st-adjustment hold for it?

2. What are all the admissible sets satisfying st-adjustment?

3. List of sets Z1, Z2, … \(\subseteq W\) such that for each Z

\[
P^*(y | \text{do}(x)) = \sum_{Z \subseteq W} P(y | \text{do}(x), z, S = 1) P^*(z)
\]

6 Result I: Graphical Criterion

A set of covariates Z is admissible for st-adjustment in D relative to X and outcome Y if:

(i) Variables in Zπ are independent of the treatment given all other covariates, and

(ii) The outcome Y is independent of all the transportability (T) and selection bias nodes (S) given the covariates Z and the treatment X.

Then, the causal effect P*(y | do(x)) is identifiable by st-adjustment on set Z with D if and only if the conditions above hold for Z relative to X and Y.

7 Result II: Search Algorithm

The paper gives a procedure to list valid adjustment sets given what variables can be measured.