

Don't be Casual about Causal Inference

- 1 Choose a measure of performance/output
- 2 Is performance better under new or old policy?

'Treatment' could be:

- 1 a new teaching method (output: reading scores)
- 2 a new medical procedure (output: recovery rate)
- 3 a new export facility (output: export profits)
- 4 etc ...

Treatment is Bad Overall

Despite showing better recovery rates for both Males and Females!

Aggregate Statistics: Is Treatment Good?

	Response			
Treatment	Lived	Died	Total	Recovery Rate
No	20	20	40	50%
Yes	16	24	40	40%
Total	36	44	80	45%



What?

New Curricula is Worse Overall

Despite being Better in each School!

Aggregate Statistics: Is New Curricula Better?

	Response		
Method	Improvement	No Improvement	Improvement Rate
Old	20	20	50%
New	16	24	40%
Total	36	44	45%



Old rocks!

Simpson's Paradox

Algebraical Representation

Simpson's Reversal of Inequalities

We may have:

$$\frac{a}{b} < \frac{\alpha}{\beta} \quad \text{and} \quad \frac{c}{d} < \frac{\gamma}{\delta}$$

while we also have:

$$\frac{a+c}{b+d} > \frac{\alpha+\gamma}{\beta+\delta}$$



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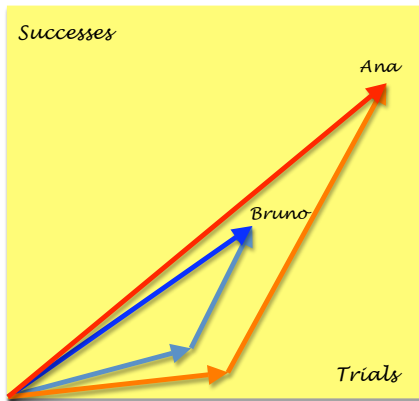
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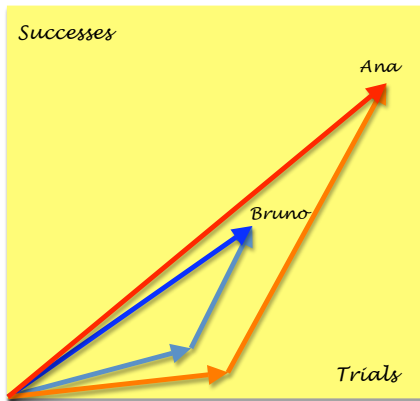
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- Bruno has higher success rate in both trial sets
- Nonetheless, Ana has higher overall success rate
- Note, for each individual, **relative** lengths of trial sets

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Lack of Randomized Controlled Experiment

Assume that the three following Facts hold:

F1 Smoking **increases** the chances of heart disease by 25%

F2 Exercise **decreases** the chances of disease by 70%

F3 Smokers exercise 40% **more** than non-smokers

World # 1 — Smoking is Good

If smoking is responsible for increasing the chances of regular exercise by 40%, then smokers will, on balance, benefit from their habit with respect to cardiovascular health.

World # 2 — Smoking is Bad

If people attracted to smoking also have an innate taste for regular exercise and visit the gym 40% more frequently, then we'll observe healthier smokers—albeit smoking in itself being bad for cardiovascular health.

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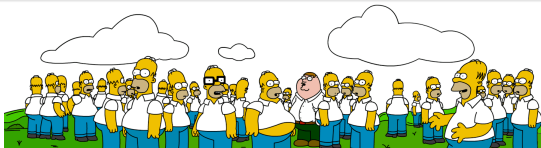
Lack of Randomized Controlled Experiment

Selection Bias

Value of an Ivy-league Education

It is not enough to compare outcomes for ivy-league and non ivy-league graduates, since students are not randomly assigned to schools.

- Maybe they're just smarter and the school doesn't make much of a difference.
- Look at students that were admitted to ivy-league schools but ended up going elsewhere — how do they perform?



Quasi-Simpson's Paradox

No Reversal

US NSF study of 1977–78 graduates

- At the bachelor's degree level the average woman with a full-time job earned 77% of the average male salary.
- But comparing salaries within each field — women in each case made at least 92% of the average male salary.
- **Lurking variable** — women were concentrated in the life sciences and social sciences which had lower salaries.
- Note that this, by itself, does not constitute evidence against gender discrimination:

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 - Why did women concentrate in those professions?

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On identifying the counterfactual

Two common Issues

- 1 Selection Bias: Adverse selection, self-selection — RCT
- 2 ... but: Contamination, contagion, propagation to control group

Do irrigation project in Region A. Productivity goes up and demand for labor spills over region B.

- 3 Solution: use distant Region as comparator ... but then it may not be that comparable.

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Example

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