

Simpson's Paradox

- **Simpson's Paradox** – occurs when analyzing heterogeneous data composed of subgroups. (trend/association/characteristic).

	Control Group (No Drug)		Treatment Group (Took Drug)	
	Heart attack	No heart attack	Heart attack	No heart attack
Female	5	1	20	19
Male	30	12	40	28
Total	13		47	49
		<u>13</u> <u>60</u>		
			<u>11</u> <u>60</u>	

BBG drug

BBB drug

Control

Drug

Bad.

	Hits/At Bats			
	1995	1996	1997	All Three Years
David Justice	104/411 = .253	45/140 = .321	163/495 = .329	312/1,046 = .298
Derek Jeter	12/48 = .250	183/582 = .314	190/654 = .291	385/1,284 = .300

Simpson Reversal

Action

A businessman contemplates buying a certain piece of property. He considers the outcome of the next presidential election relevant. So, to clarify the matter to himself, he asks whether he would buy if he knew that the Democratic candidate were going to win, and decides that he would. Similarly, he considers whether he would buy if he knew that the Republican candidate were going to win, and again finds that he would. Seeing that he would buy in either event, he decides that he should buy, even though he does not know which event obtains, or will

Action → Property
Elections (D/R).

Some thing principle.

Action → Outcome

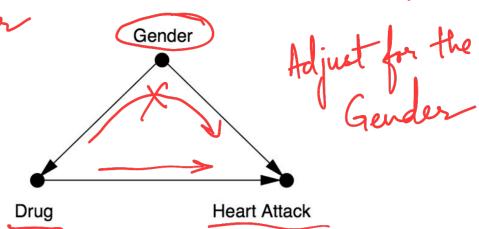
Event C

BBG

Drug → Heart Attack

Gender.

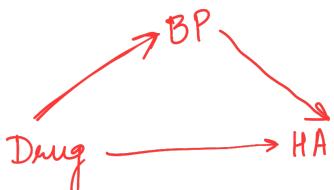
Gender is a confounder



Placebo

	Control Group (No Drug)		Treatment Group (Took Drug)	
	Heart attack	No heart attack	Heart attack	No heart attack
Low blood pressure	1	51	19	3
High blood pressure	12	30	28	8
Total	13	47	11	49
Pooled	→ $\frac{13}{60}$		(11/60)	

BP is a mediator



Do not adjust for the mediator (BP)
∴ Pooling / Aggregation is the right thing to do.

- In an observational study published in 1996, open surgery to remove kidney stones had a better success rate than endoscopic surgery for small kidney stones. It also had a better success rate for large kidney stones. However, it had a lower success rate overall. Just as in our first example, this was a case where the choice of treatment was related to the severity of the patients' case: larger stones were more likely to lead to open surgery and also had a worse prognosis.

Adjust for the confounder surgery → Outcome
Stone

- In a study of thyroid disease published in 1995, smokers had a higher survival rate (76 percent) over twenty years than nonsmokers (69 percent). However, the nonsmokers had a better survival rate in six out of seven age groups, and the difference was minimal in the seventh. Age was clearly a confounder of Smoking and Survival: the average smoker was younger than the average nonsmoker (perhaps because the older smokers had already died). Stratifying the data by age, we conclude that smoking has a negative impact on survival.

Partitioning the data:
Smoking → Age → Survival

Fairness

Type of discrimination:

- 1) Direct discrimination
- 2) Indirect
- 3) Systemic discrimination.
- 4) Statistical.
- 5) Explainable discrimination. / Unexplainable

		Predicted	
		True	False
Label	True	TP	(FN) d.denied.
	False	(FP) u.given.	T N

Equalized odds TP, FP rates are the same for all the protected groups.

Equal Opportunities TP

Demographic Parity Likelihood of positive outcome is the same.

[Fairness through Awareness] Similar individuals should get similar predictions.

[Fairness through Unawareness] Don't use the protected attribute

Treatment Equality $\left(\frac{FN}{FP}\right)$ is the same for the protected groups