COUNTERFACTUALS AND DAGS II

PMAP 8521: Program Evaluation for Public Service

September 30, 2019

Fill out your reading report on iCollege!

PLAN FOR TODAY

Causal models

Backdoors and adjustment

Bad controls

Potential outcomes

Questions!

CAUSAL MODELS

What is the causal effect of an additional year of education on earnings?

Step 1: List variables

Step 2: Simplify

Step 3: Connect arrows

Step 4: Use logic and math to determine which nodes and arrows to measure

1. LIST VARIABLES

Education (treatment)

Earnings (outcome)

List anything that's relevant

Things that cause or are caused by treatment, especially if they're related to both treatment and outcome

You don't have to actually observe or measure them all

1. LIST VARIABLES

Education (treatment)

Earnings (outcome)

Location

Ability

Demographics

Socioeconomic status

Year of birth

Compulsory schooling laws

Job connections

2. SIMPLIFY

Education (treatment)

Earnings (outcome)

Location

Ability

Demographics

Socioeconomic status

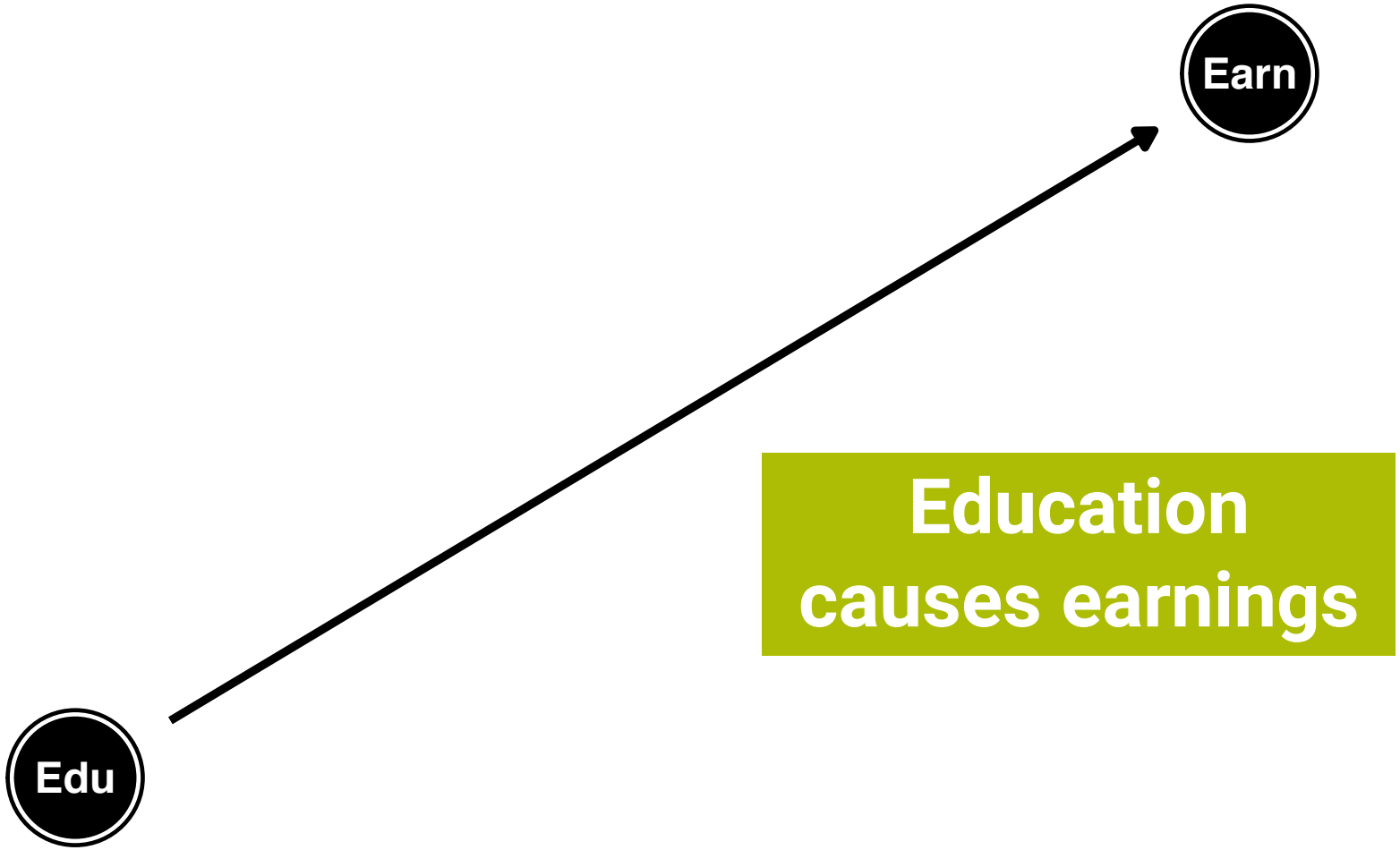
Year of birth

Compulsory schooling laws

Job connections

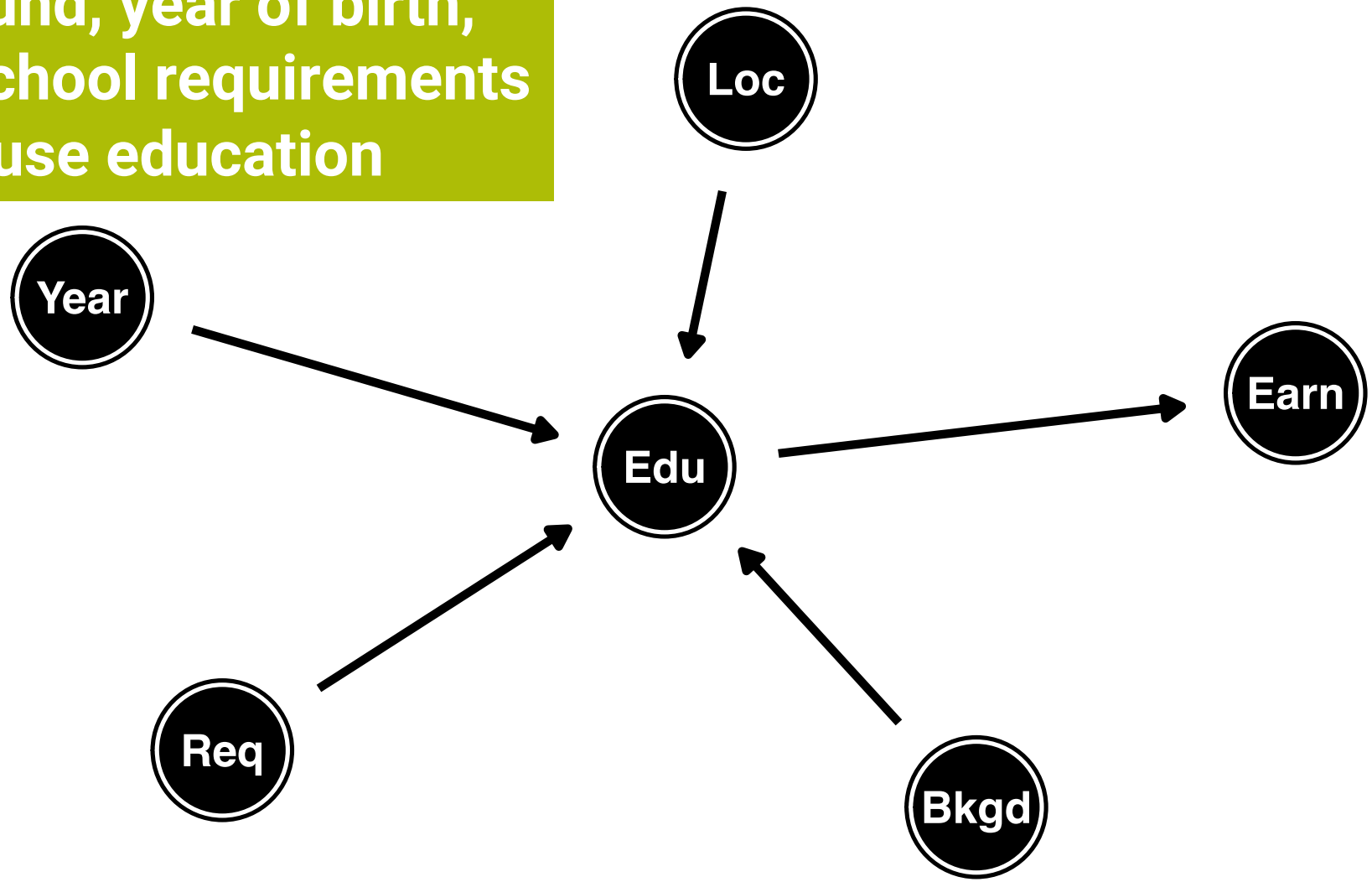
Background

3. DRAW ARROWS

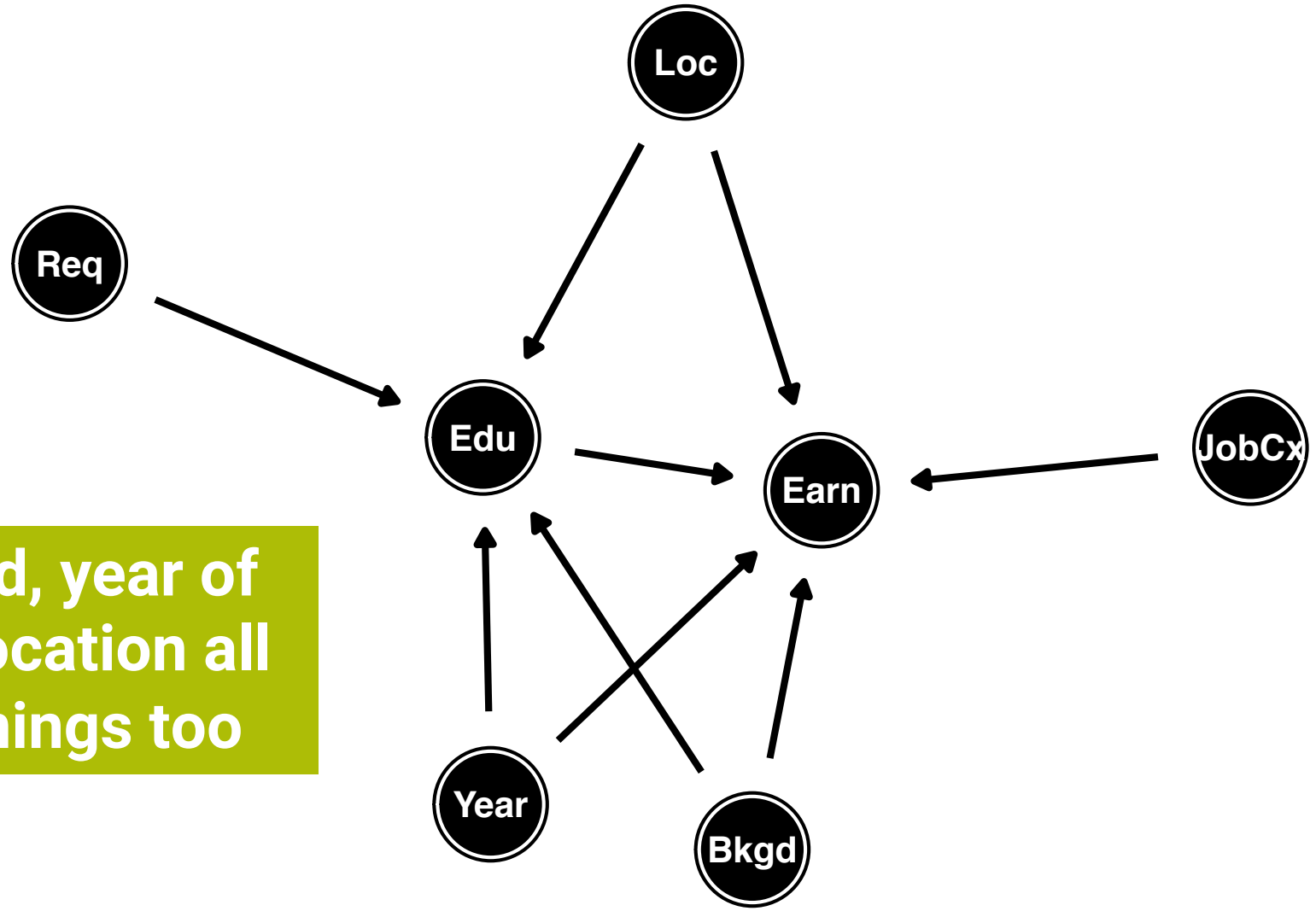


3. DRAW ARROWS

Background, year of birth, location, school requirements all cause education

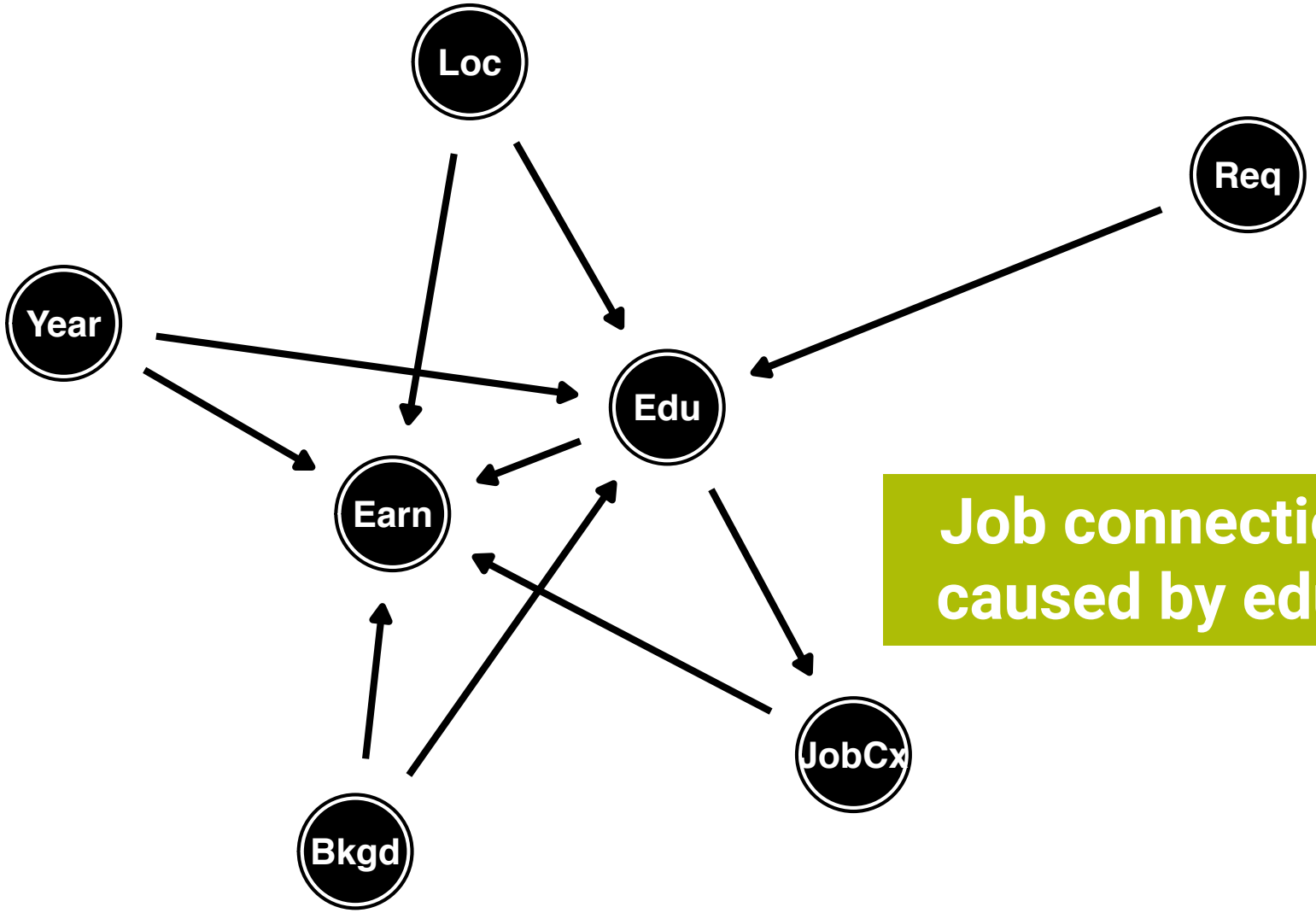


3. DRAW ARROWS



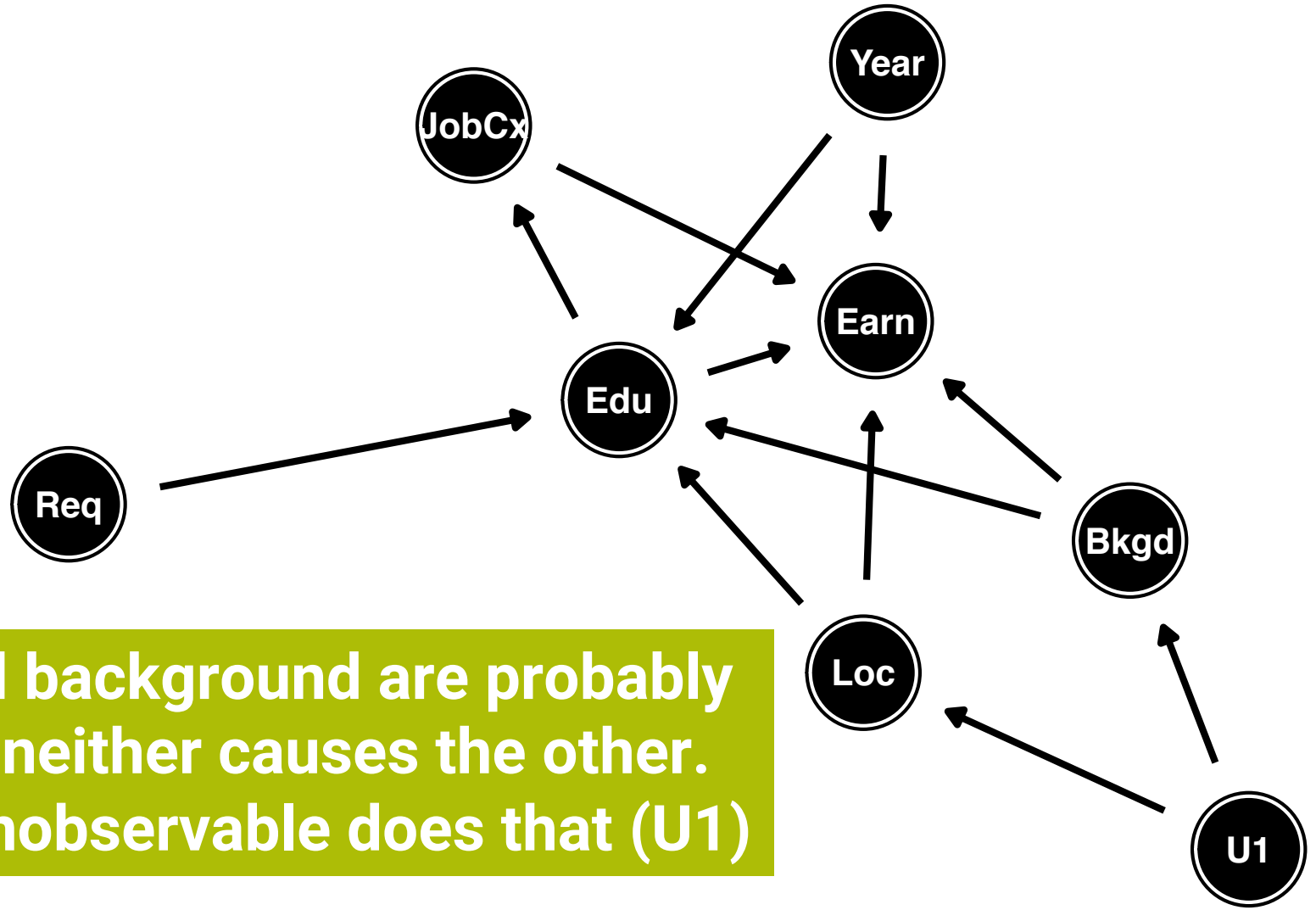
Background, year of birth, and location all effect earnings too

3. DRAW ARROWS



Job connections are caused by education

3. DRAW ARROWS

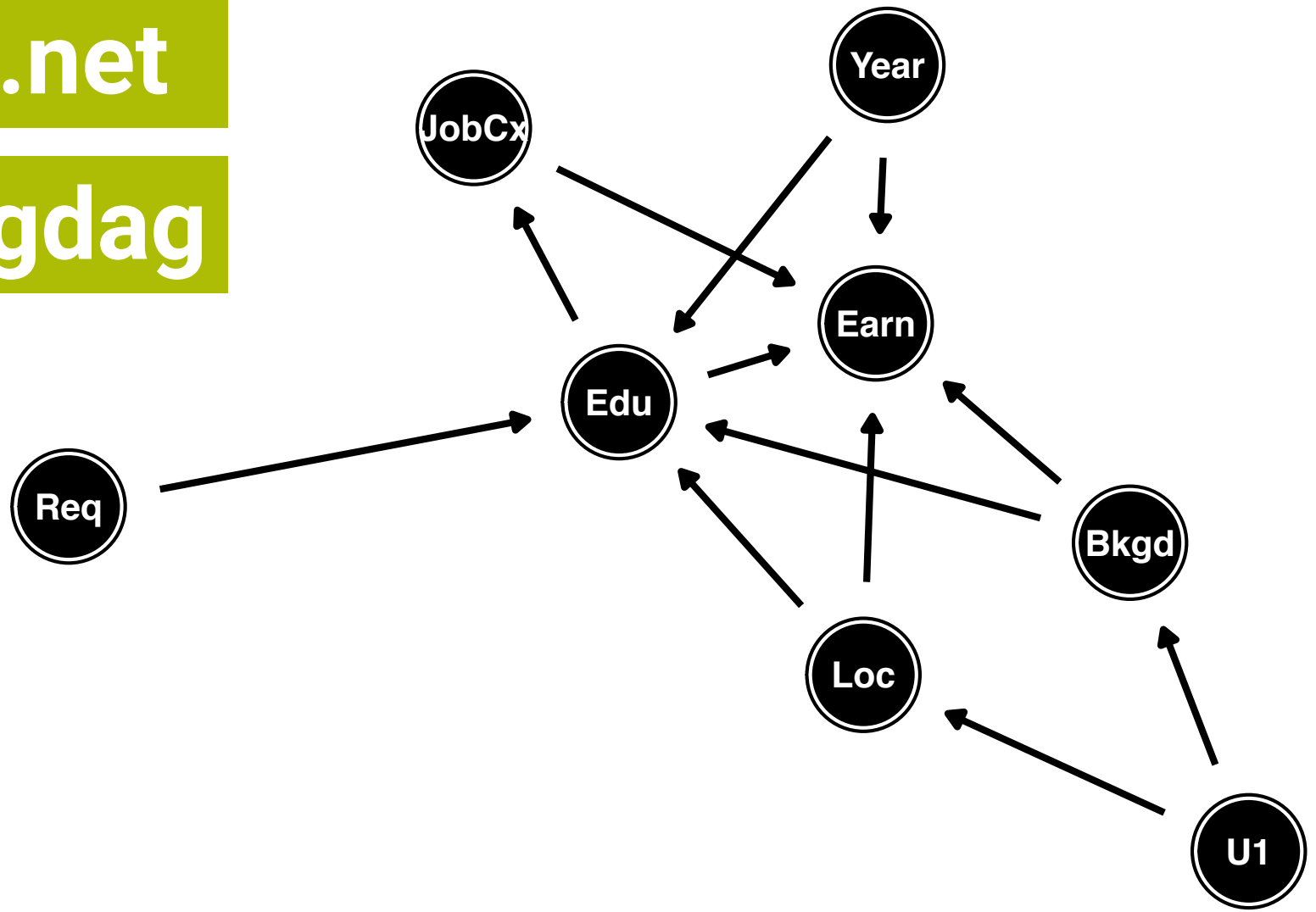


Location and background are probably related, but neither causes the other. Something unobservable does that (U1)

LET THE COMPUTER DO THIS

dagitty.net

R and ggdag



YOUR TURN

Does a daily glass of red wine make you live longer?

Step 1: List variables

Step 2: Simplify

Step 3: Connect arrows

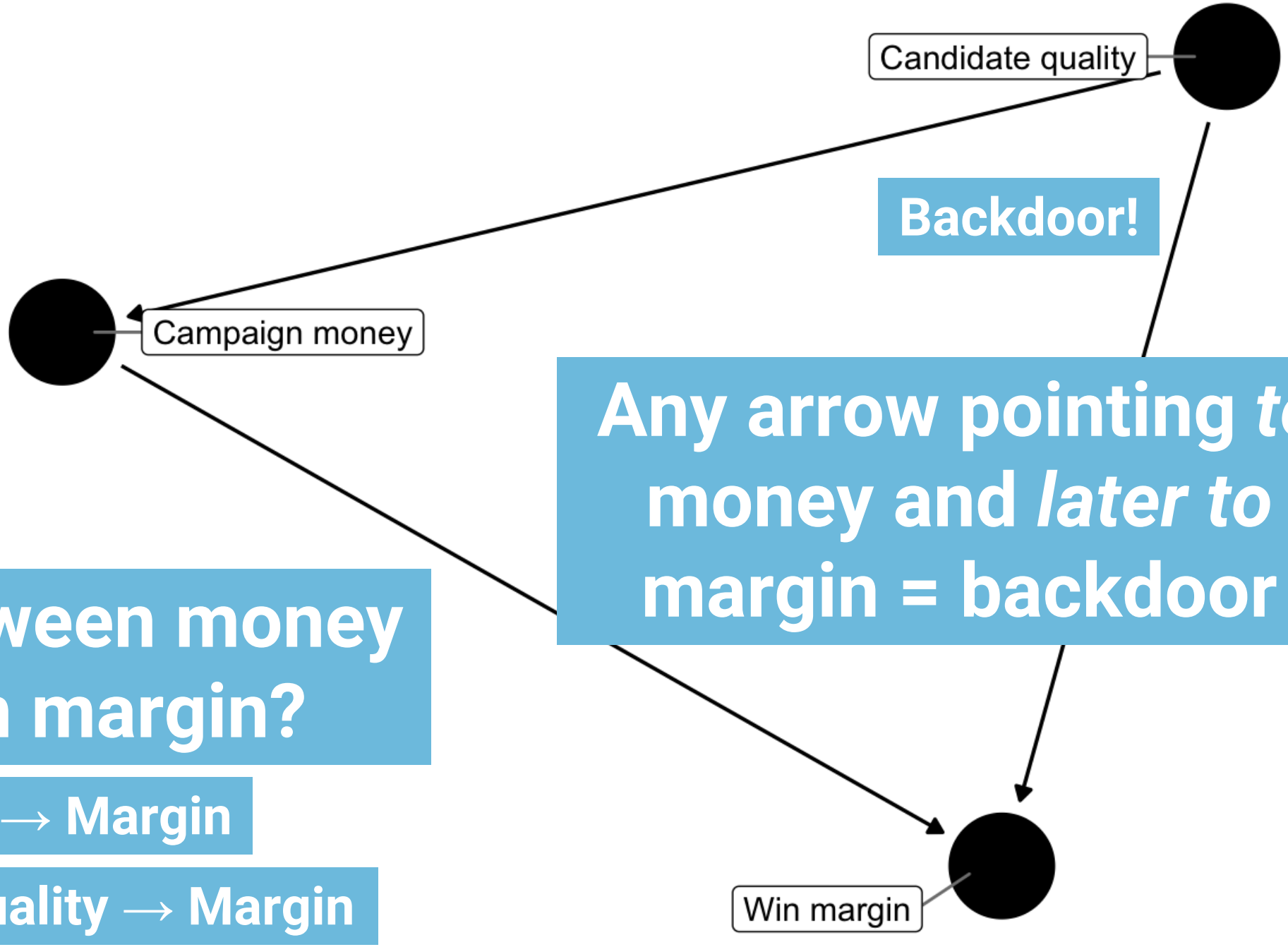
Use dagitty.net and R

BACKDOORS AND ADJUSTMENT

ISOLATE / IDENTIFY

Goal of causal inference is to isolate specific effects

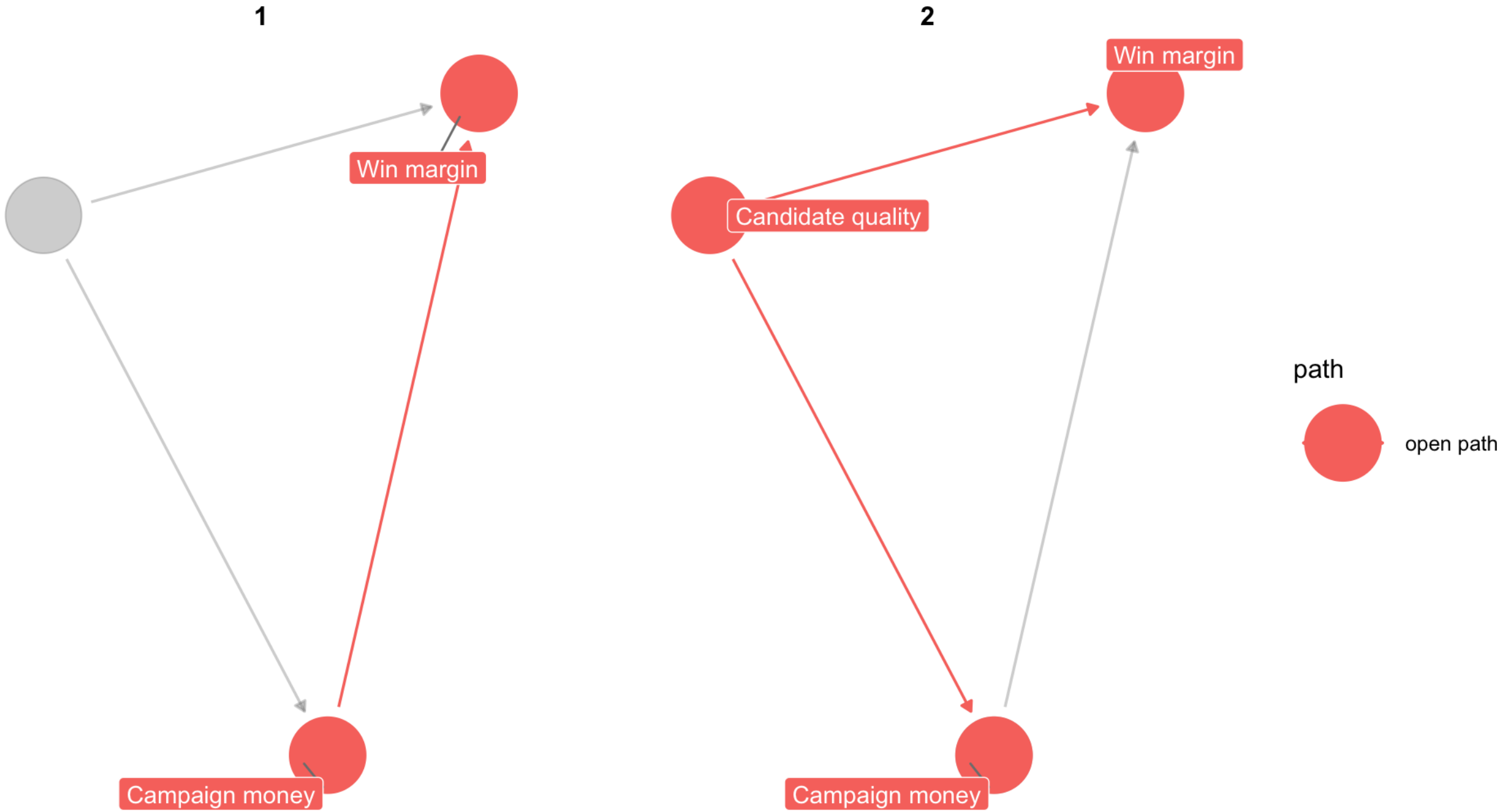
There's not always a single path between treatment and outcome



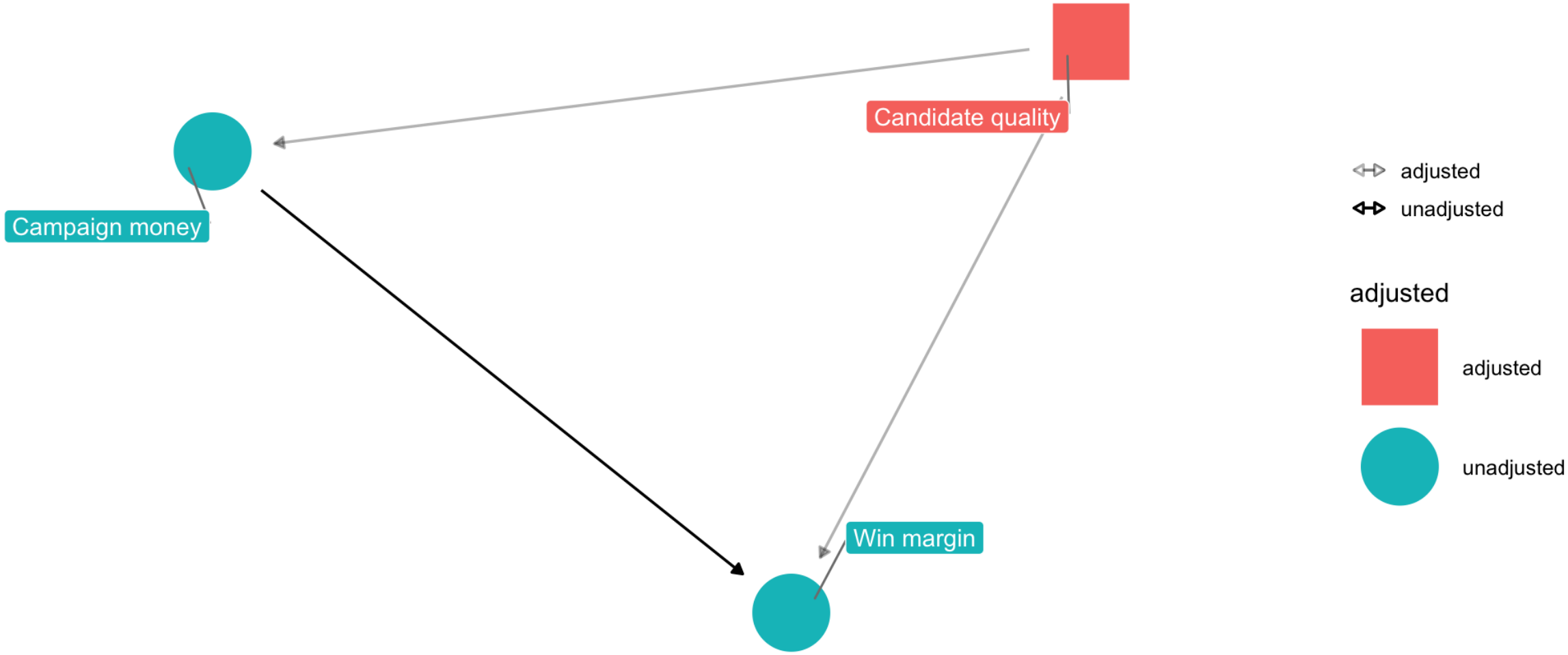
Paths between money and win margin?

Money → Margin

Money ← Quality → Margin

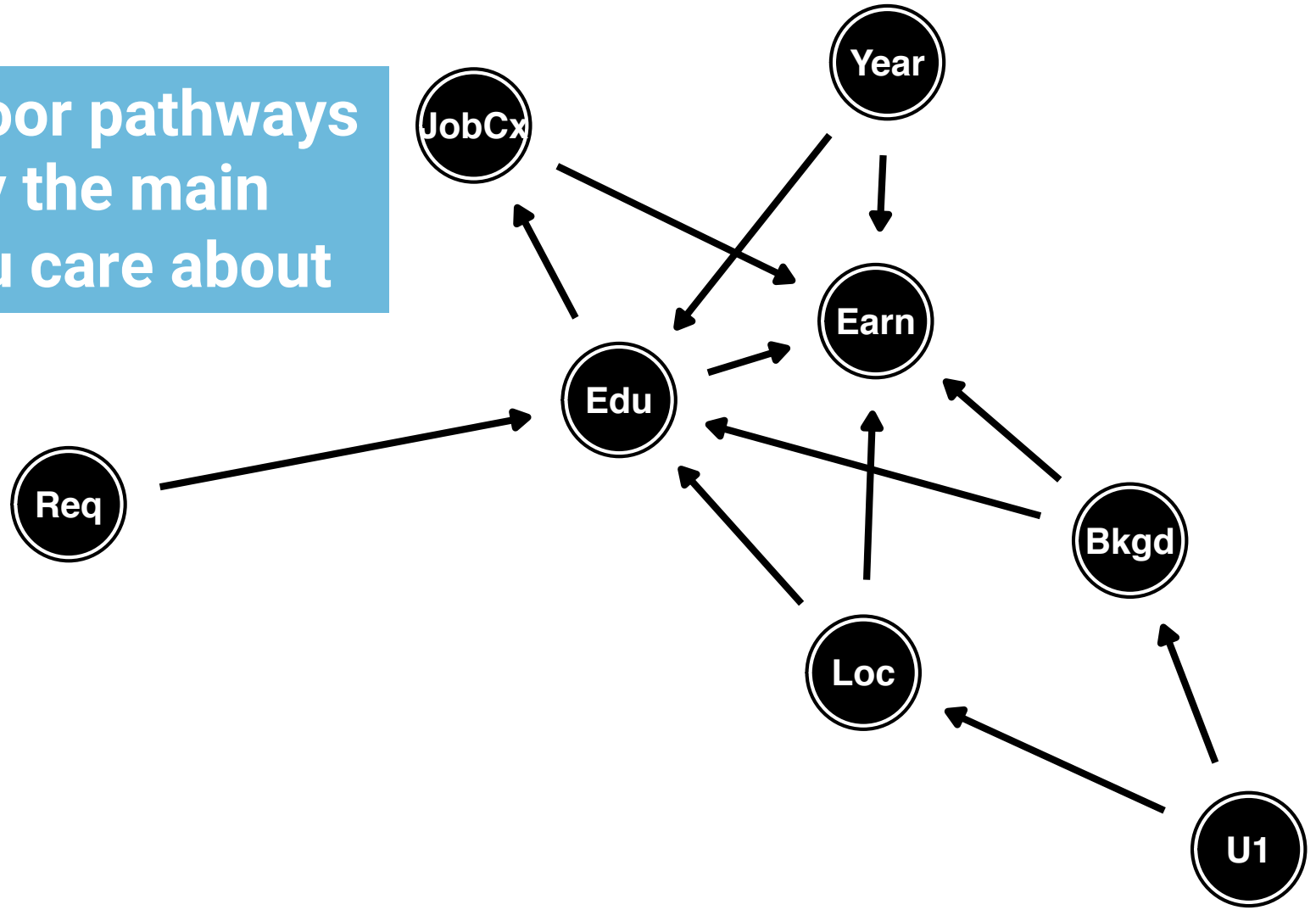

1
Win margin
Campaign money
2
Win margin
Candidate quality
Campaign money
path
open path

CLOSE BACKDOOR PATHS



4. MEASURE AND CONTROL FOR STUFF

Block backdoor pathways to identify the main pathway you care about



ALL PATHS

Education → Earnings

Education → Job connections → Earnings

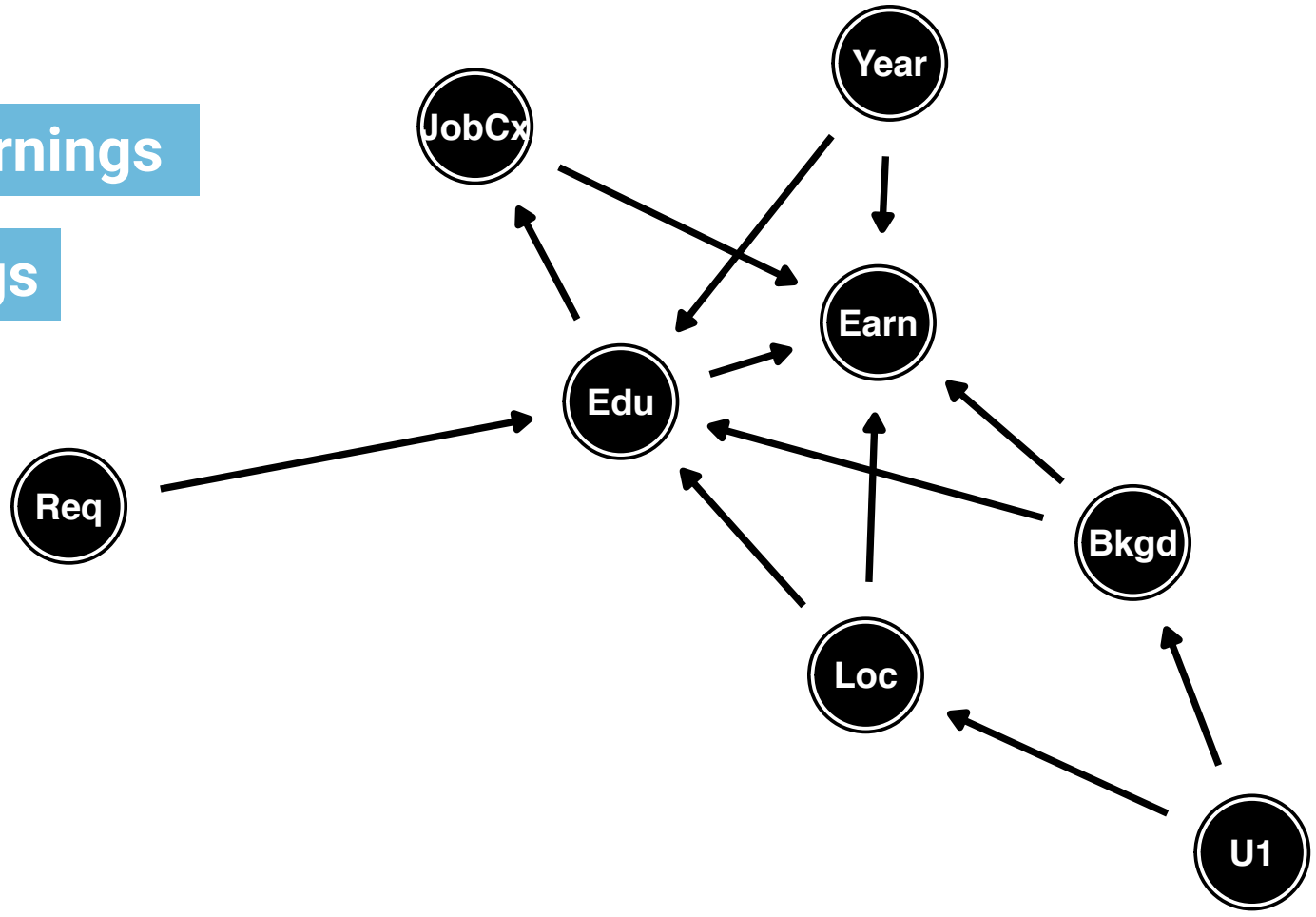
Education ← Background → Earnings

Education ← Background ← U1 → Location → Earnings

Education ← Location → Earnings

Education ← Location ← U1 → Background → Earnings

Education ← Year → Earnings



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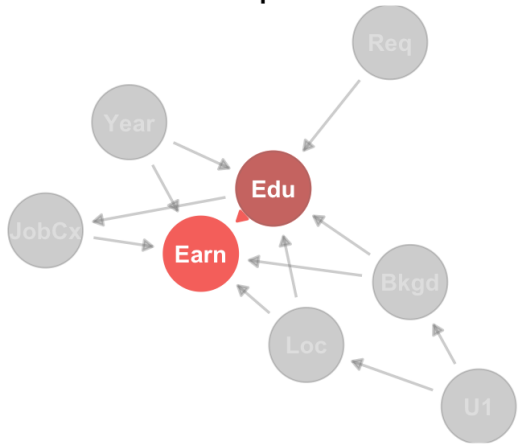
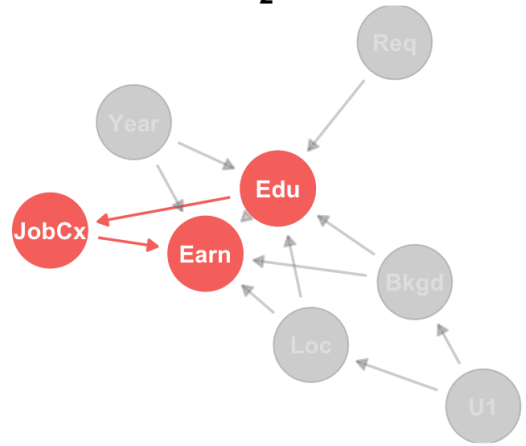


2



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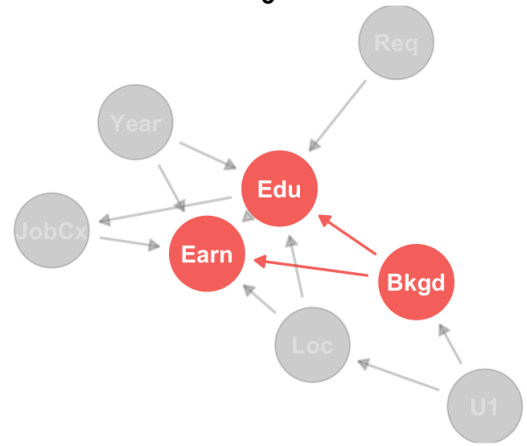

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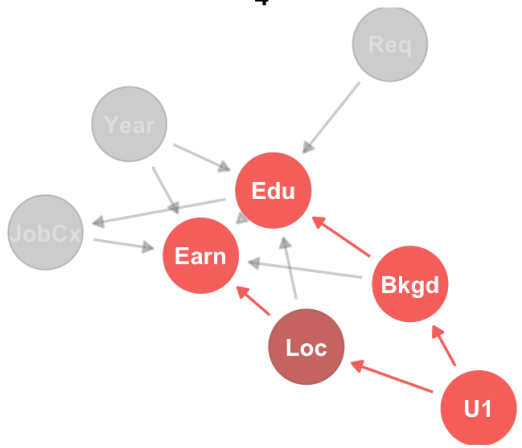

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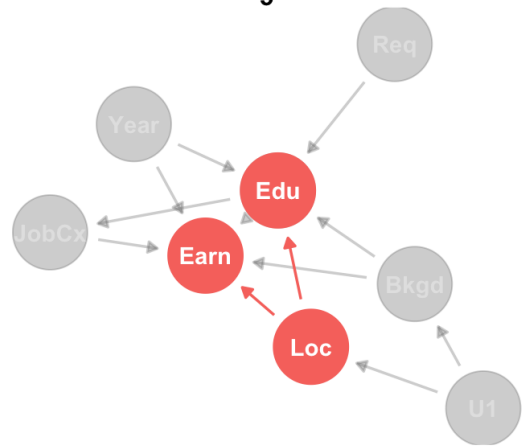

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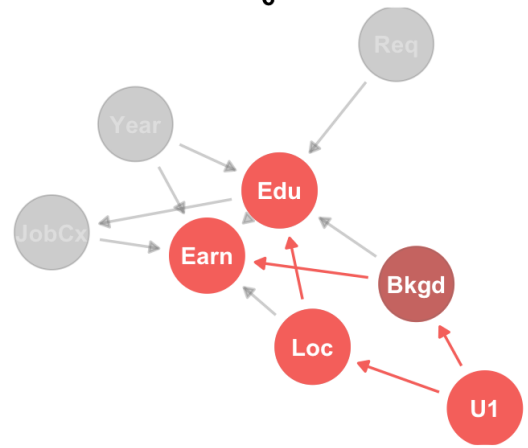
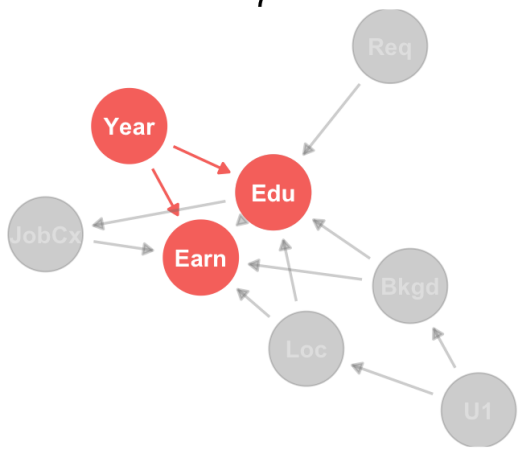


path

a open path

7



CLOSING DOORS

Education → Earnings

Education → Job connections → Earnings

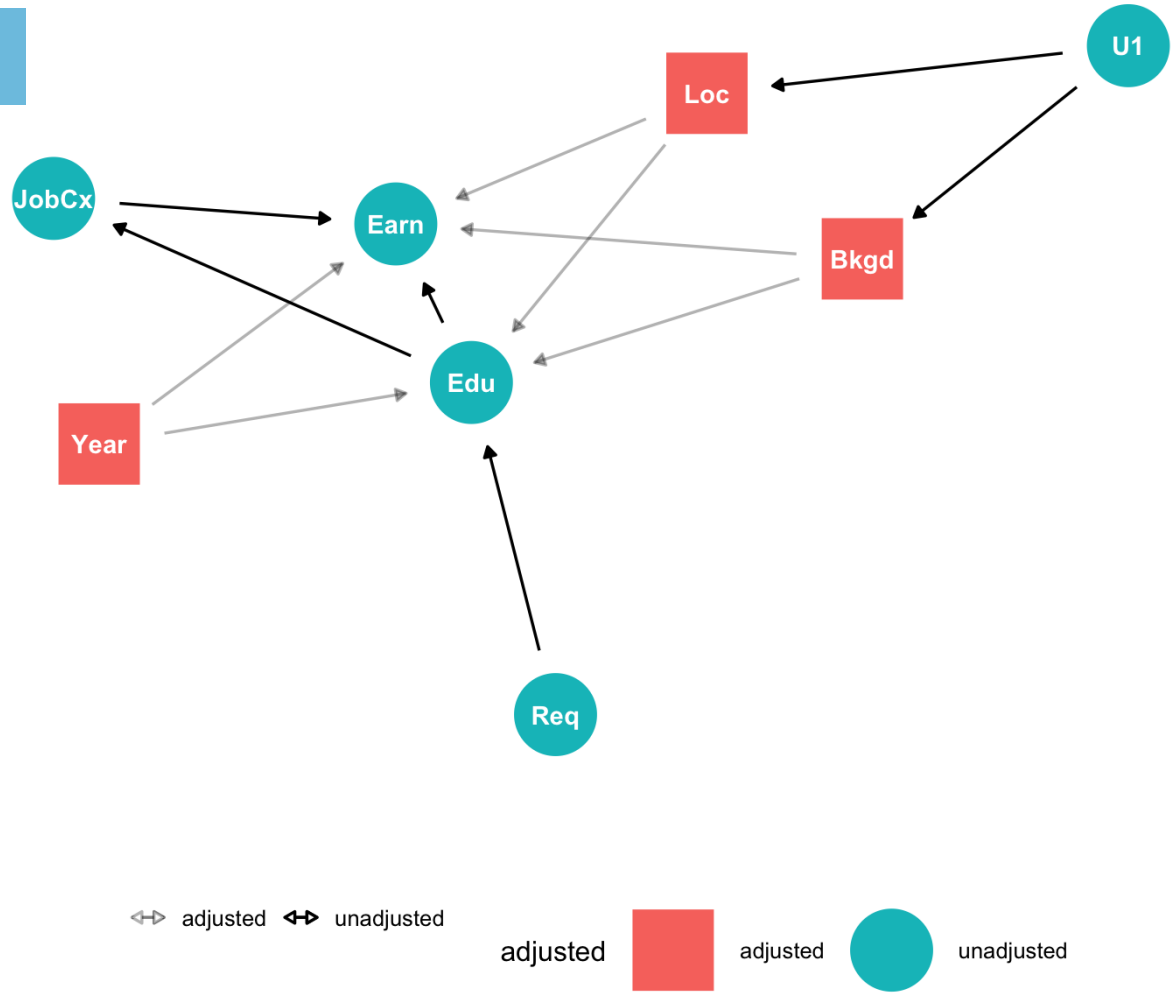
Education ← Background → Earnings

Education ← Background ← U1 → Location → Earnings

Education ← Location → Earnings

Education ← Location ← U1 → Background → Earnings

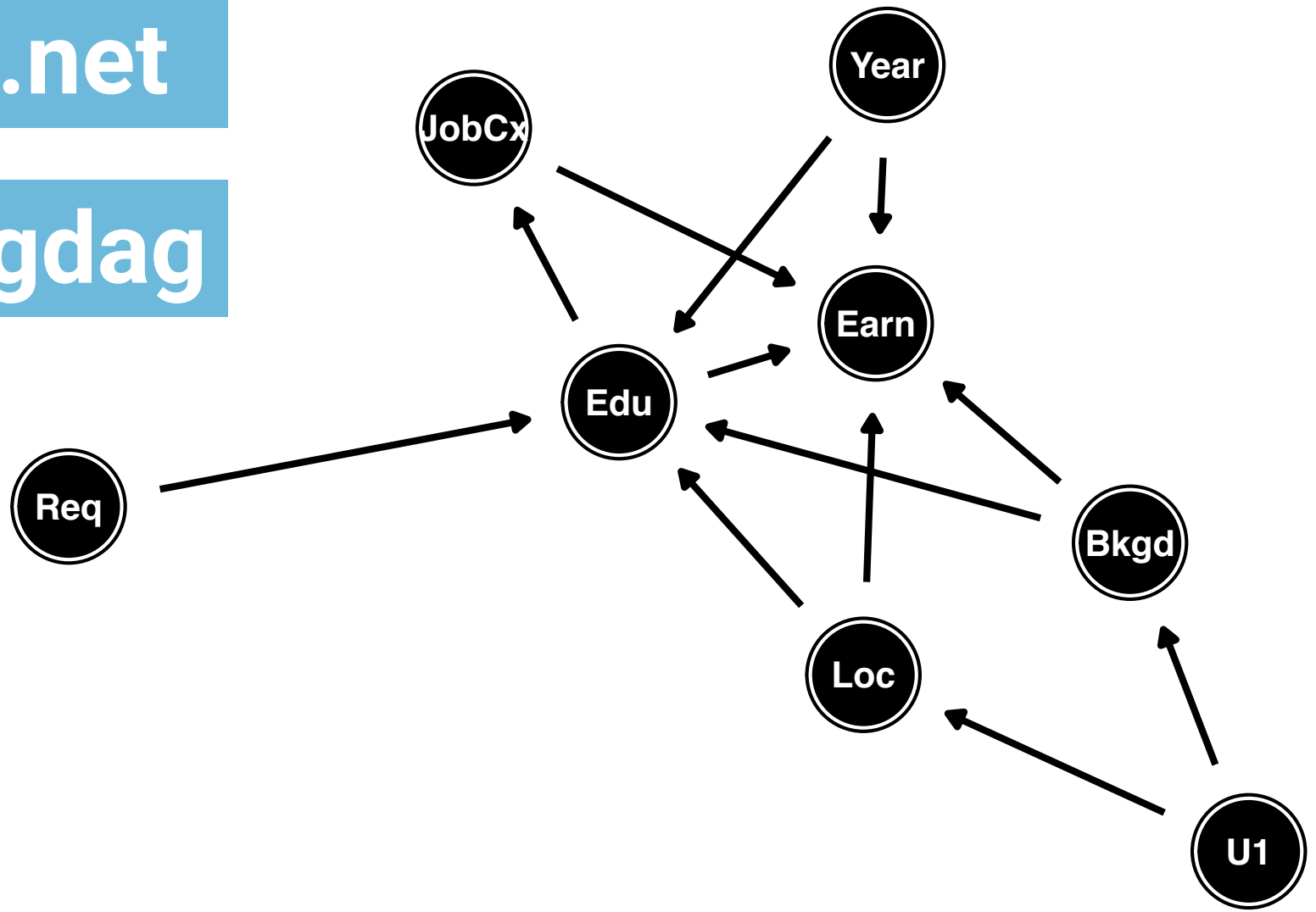
Education ← Year → Earnings

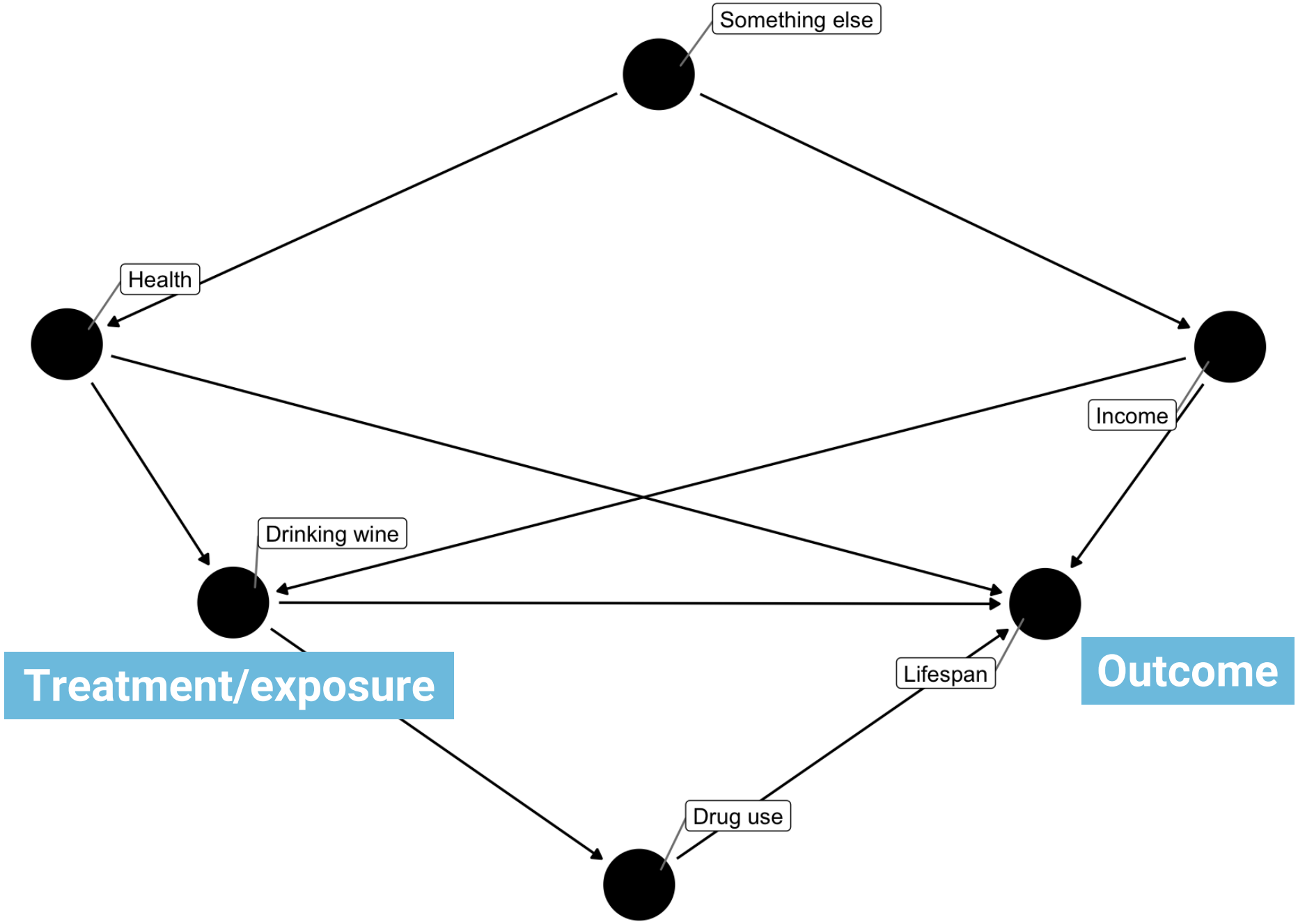


LET THE COMPUTER DO THIS AGAIN

dagitty.net

R and ggdag




Something else
Health
Income
Drinking wine
Treatment/exposure
Lifespan
Outcome
Drug use

Wine → Lifespan

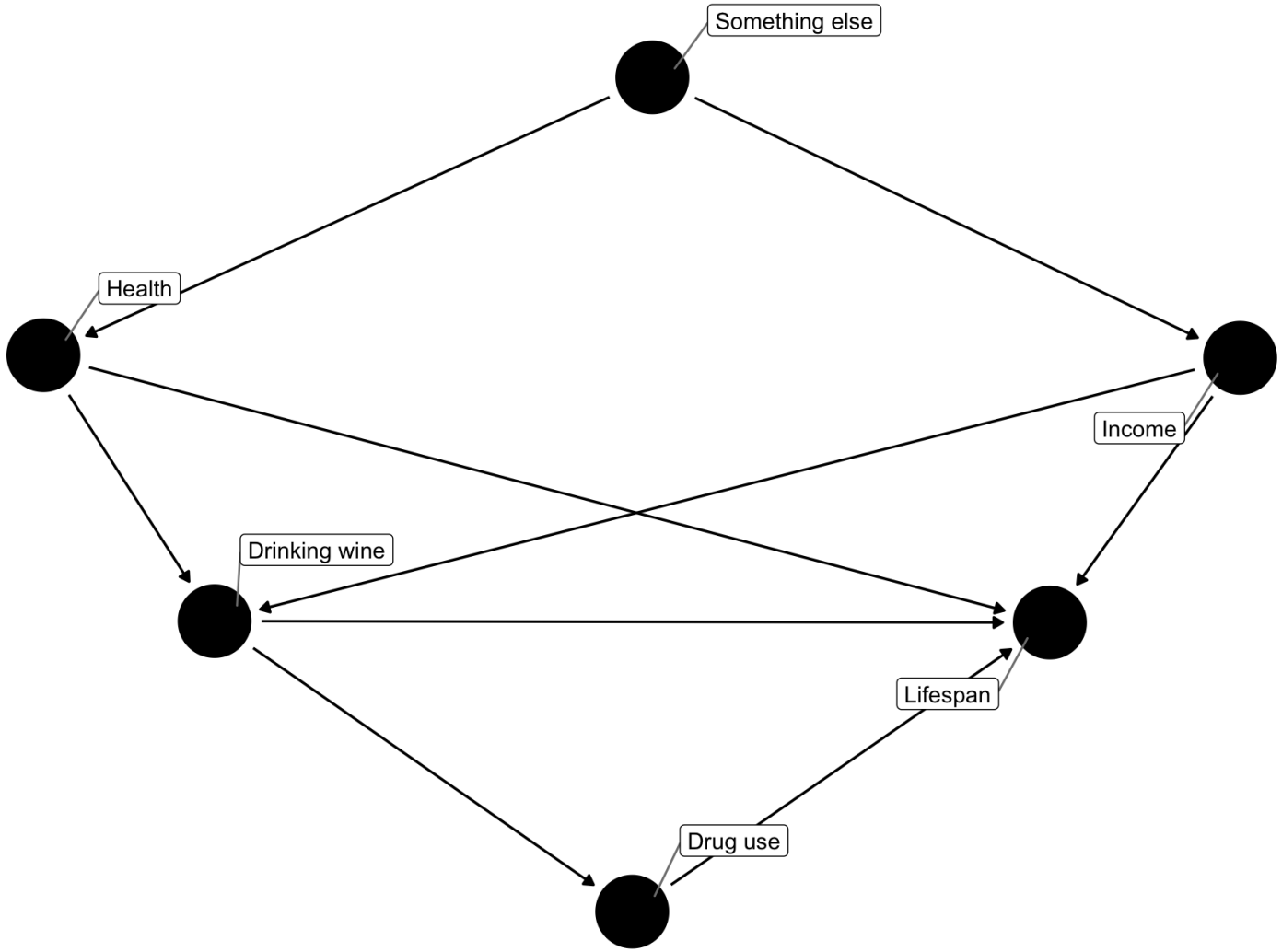
Wine → Drugs→ Lifespan

Wine ← Health → Lifespan

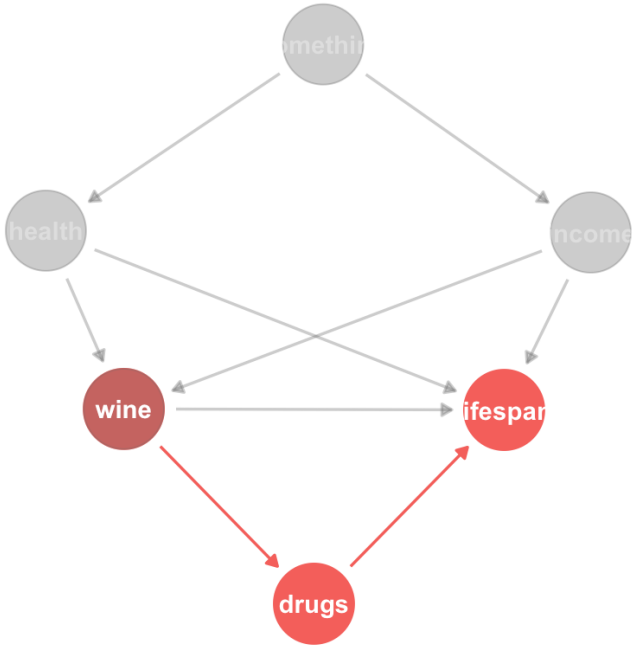
Wine ← Health ← Something → Income → Lifespan

Wine ← Income → Lifespan

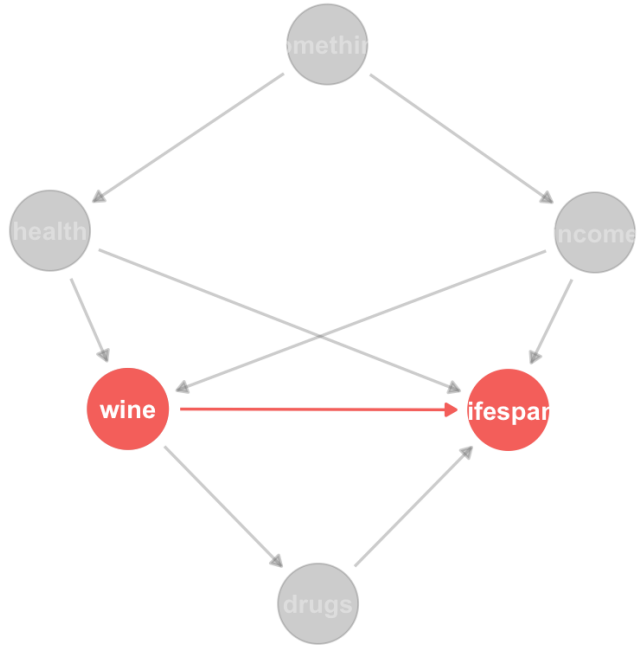
Wine ← Income ← Something → Health → Lifespan



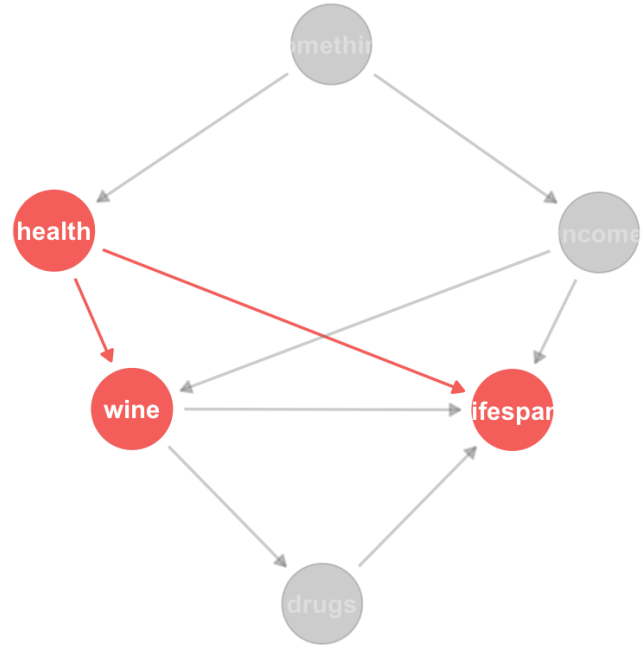
1


wine
drugs

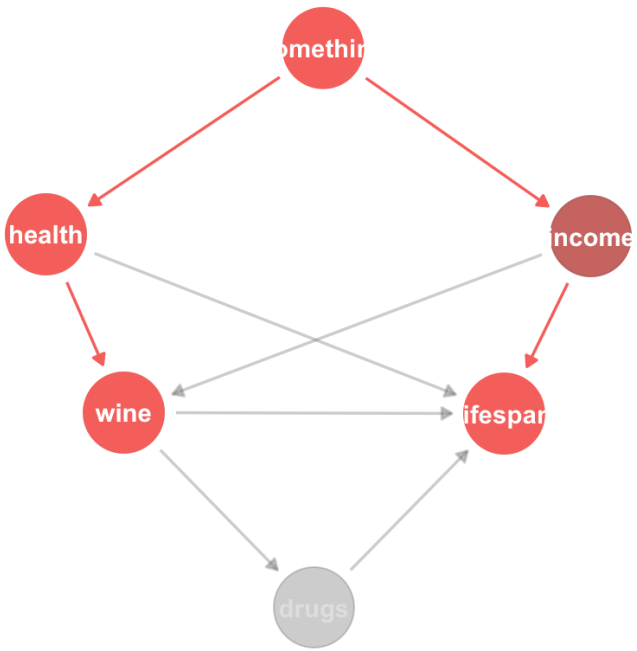
2


wine
drugs

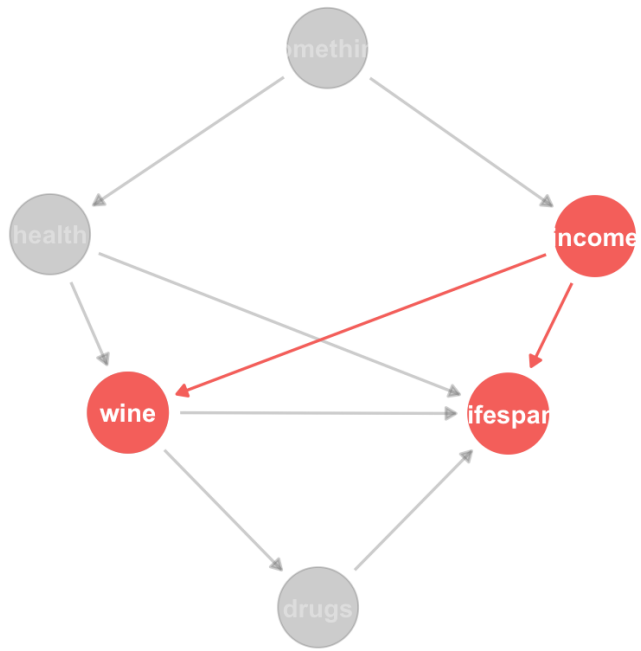
3


health
wine
drugs

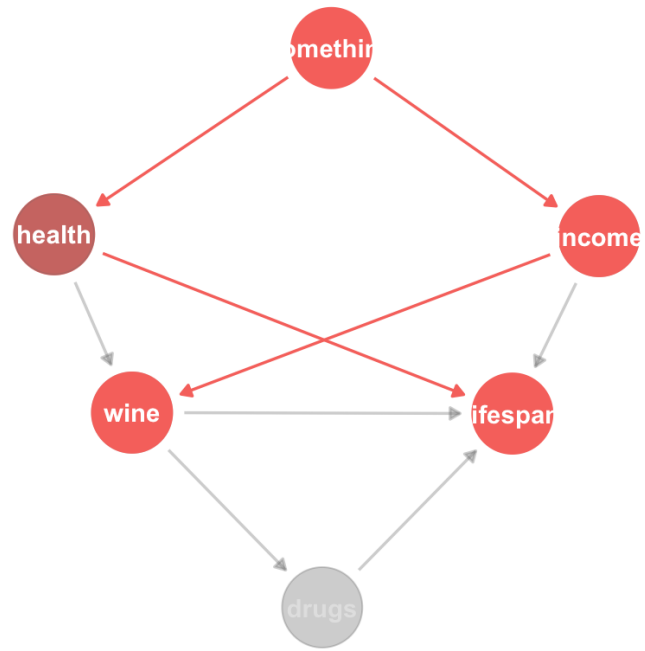
4


health
wine
drugs

5


wine
drugs

6


health
wine
drugs

Wine → Lifespan

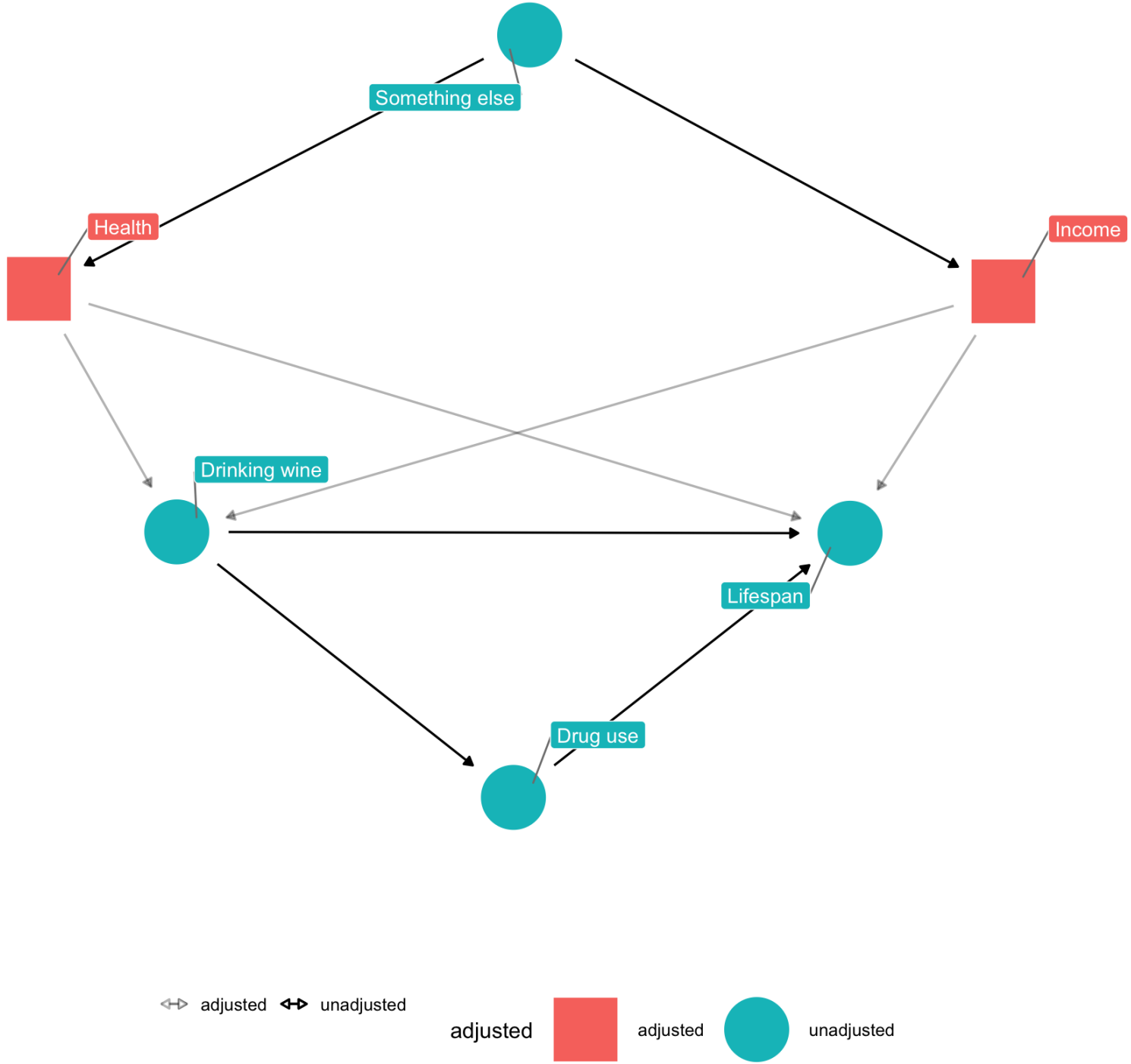
Wine → Drugs→ Lifespan

Wine ← Health → Lifespan

Wine ← Health ← Something → Income → Lifespan

Wine ← Income → Lifespan

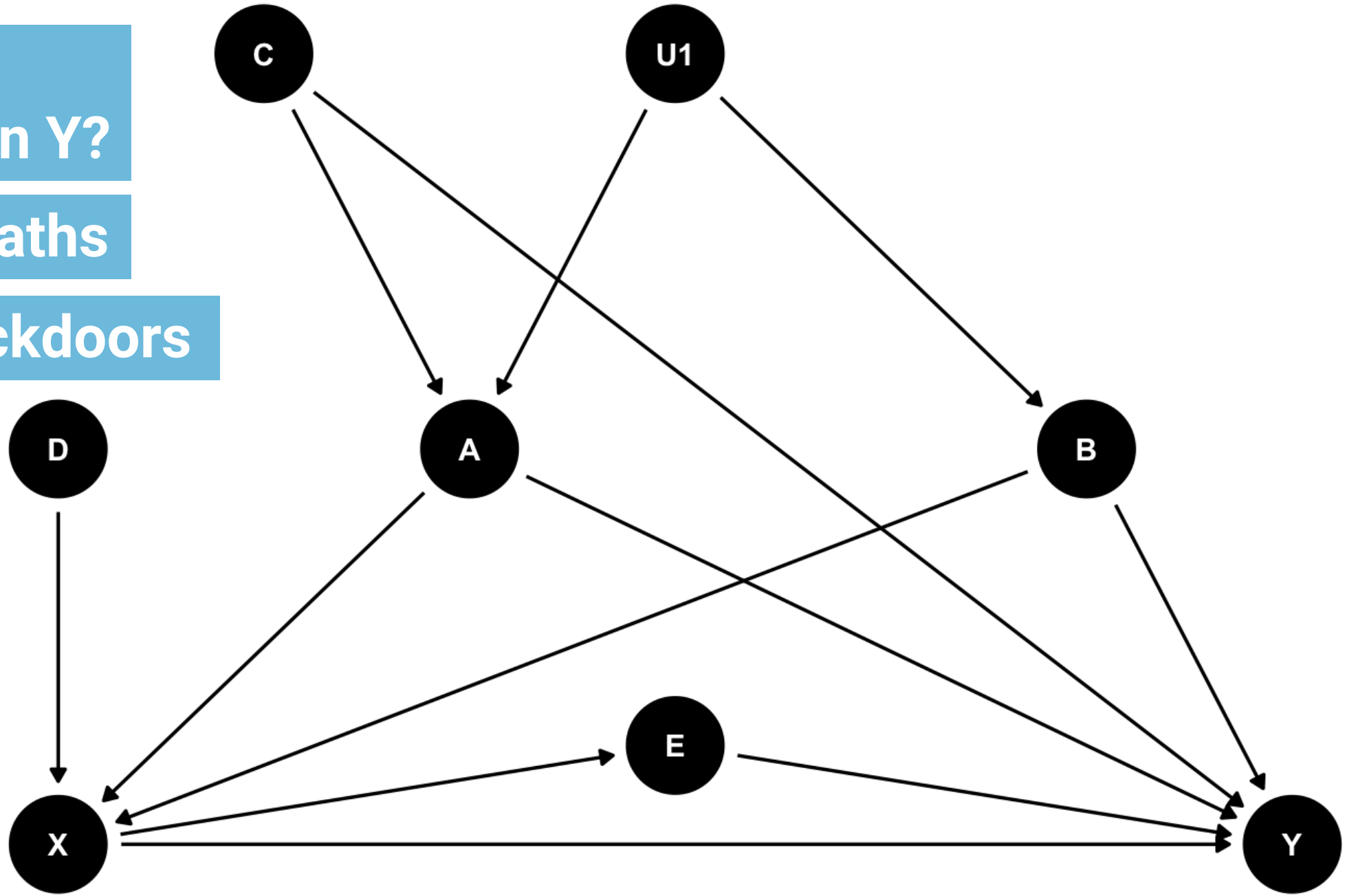
Wine ← Income ← Something → Health → Lifespan



What is the effect of X on Y?

List all the paths

Close all backdoors

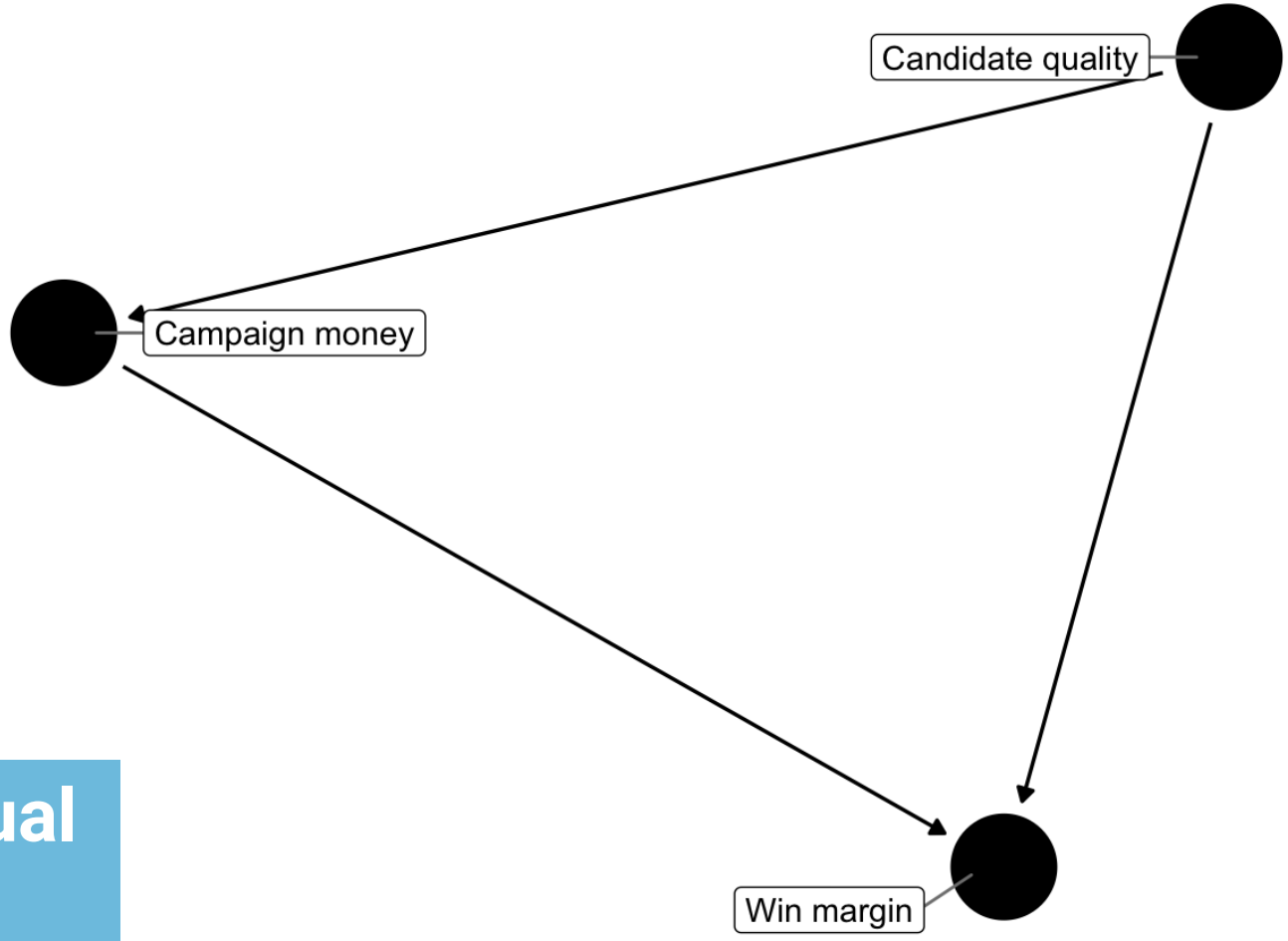


ADJUSTING & CONTROLLING

Find what part of X (campaign money) is explained by Q (quality), subtract it out. This creates the residual part of X.

Find what part of Y (the win margin) is explained by Q (quality), subtract it out. This creates the residual part of Y.

Find relationship between residual part of X and residual part of Y. This is the causal effect.

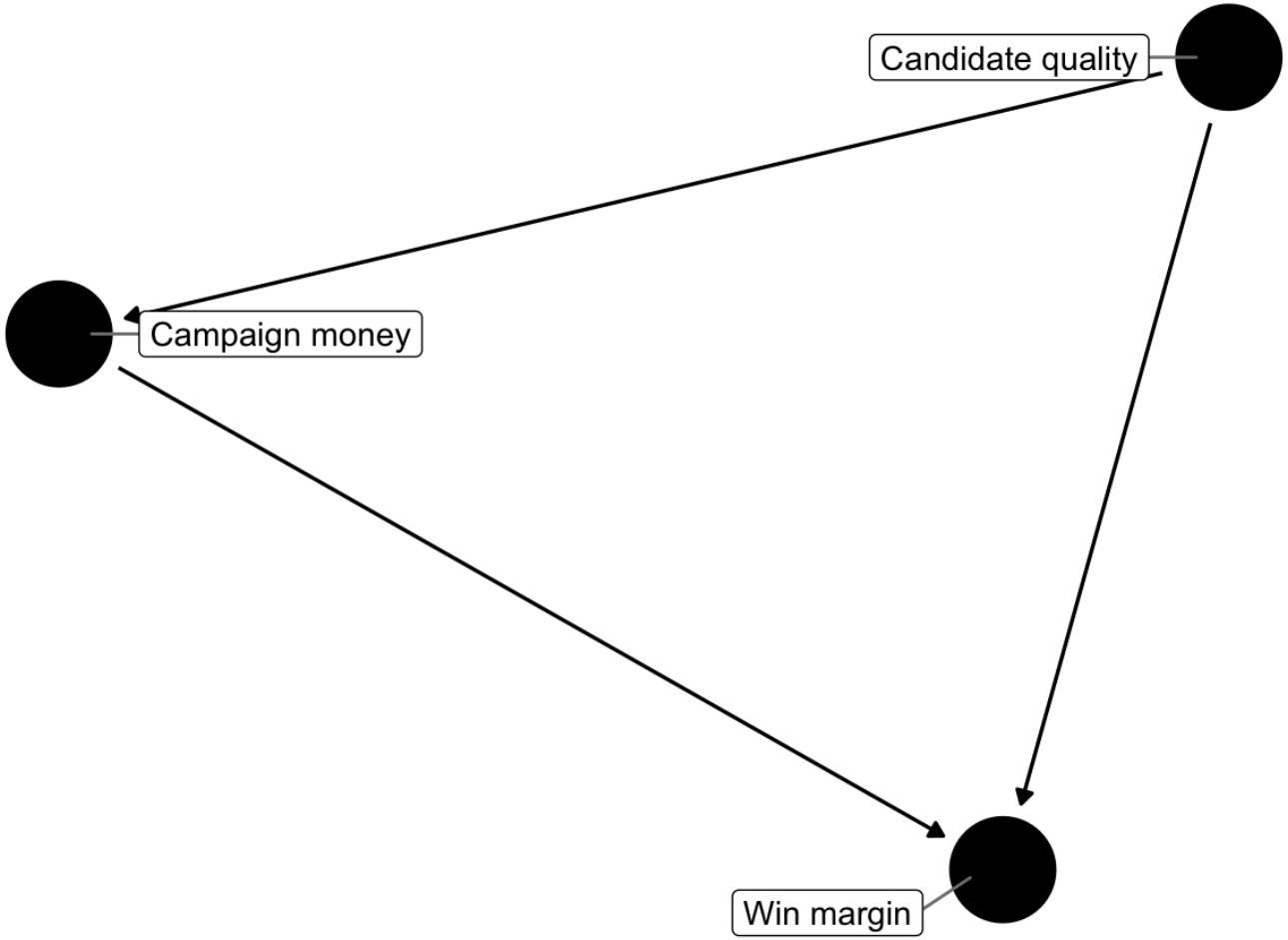


ADJUSTING & CONTROLLING

We're comparing candidates as if they had the same quality

We remove differences that are predicted by quality

Holding quality constant



HOW TO ADJUST?

Include term in regression

$$\text{Win margin} = \beta_0 + \beta_1 \text{Campaign money} + \beta_2 \text{Candidate quality} + \epsilon$$

$$\text{Win margin} = \alpha + \beta\ \text{Campaign money} + \gamma\ \text{Candidate quality} + \epsilon$$

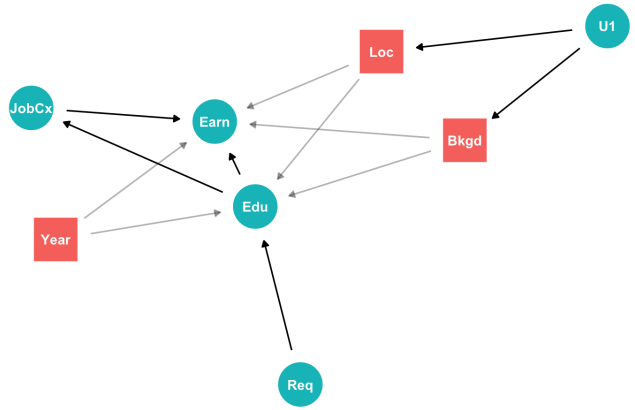
Create similar subsamples

(LaLonde example)

CLOSING DOORS

$$\text{Earnings} = \beta_0 + \beta_1 \text{Education} + \beta_2 \text{Location} + \beta_3 \text{Background} + \beta_4 \text{Year} + \epsilon$$

$$\text{Earnings} = \alpha + \beta \text{Education} + \gamma_1 \text{Location} + \gamma_2 \text{Background} + \gamma_3 \text{Year} + \epsilon$$



PRACTICE!

Go to andhs.co/nyt and read the article

Pick one of the causal claims in the article

(There are a lot! Look for words like “improve”, “affect”, and “reduces)

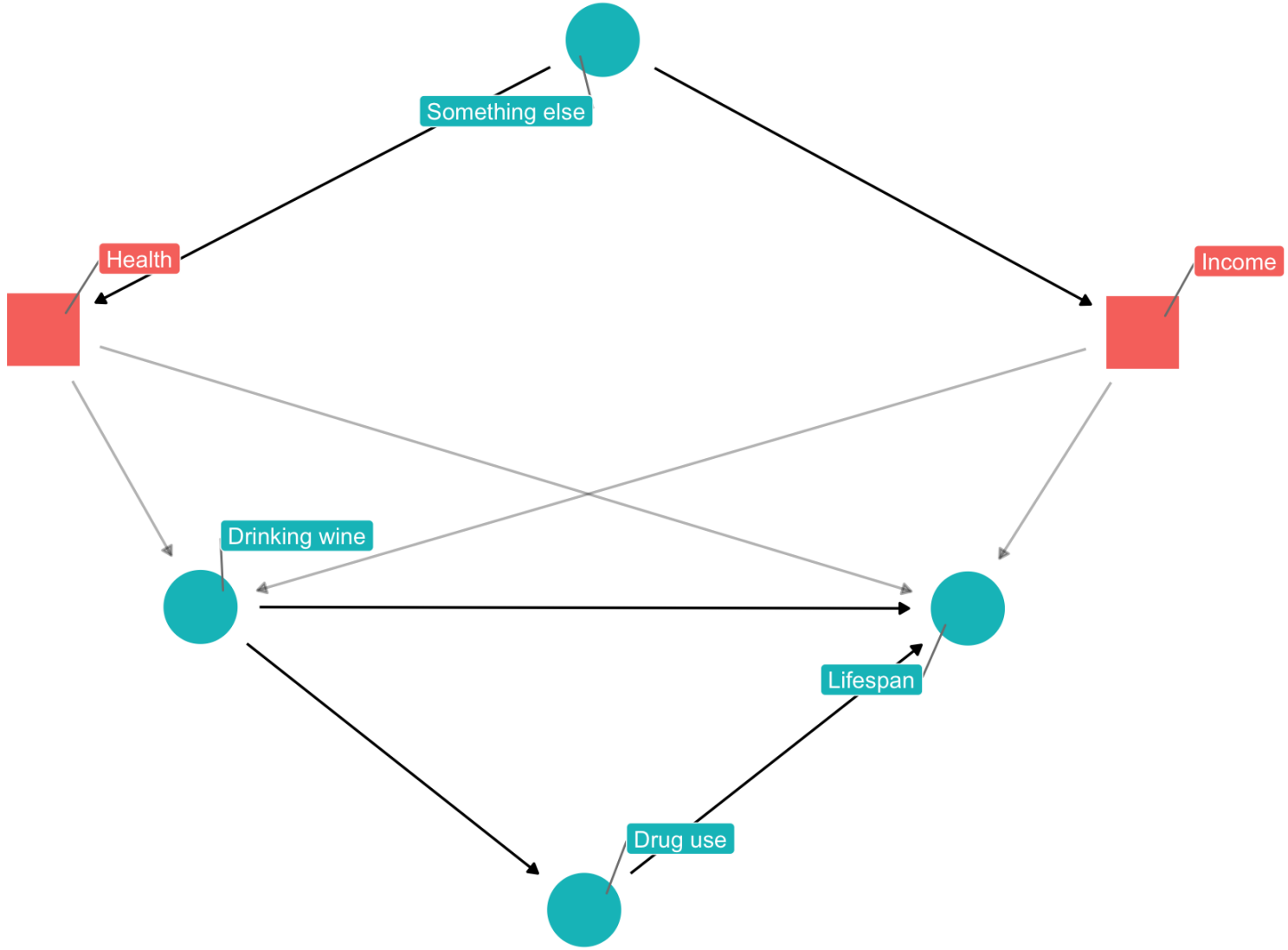
Draw a diagram for that causal claim

Determine what needs to be controlled for to identify the effect

Do another claim if time

BAD CONTROLS

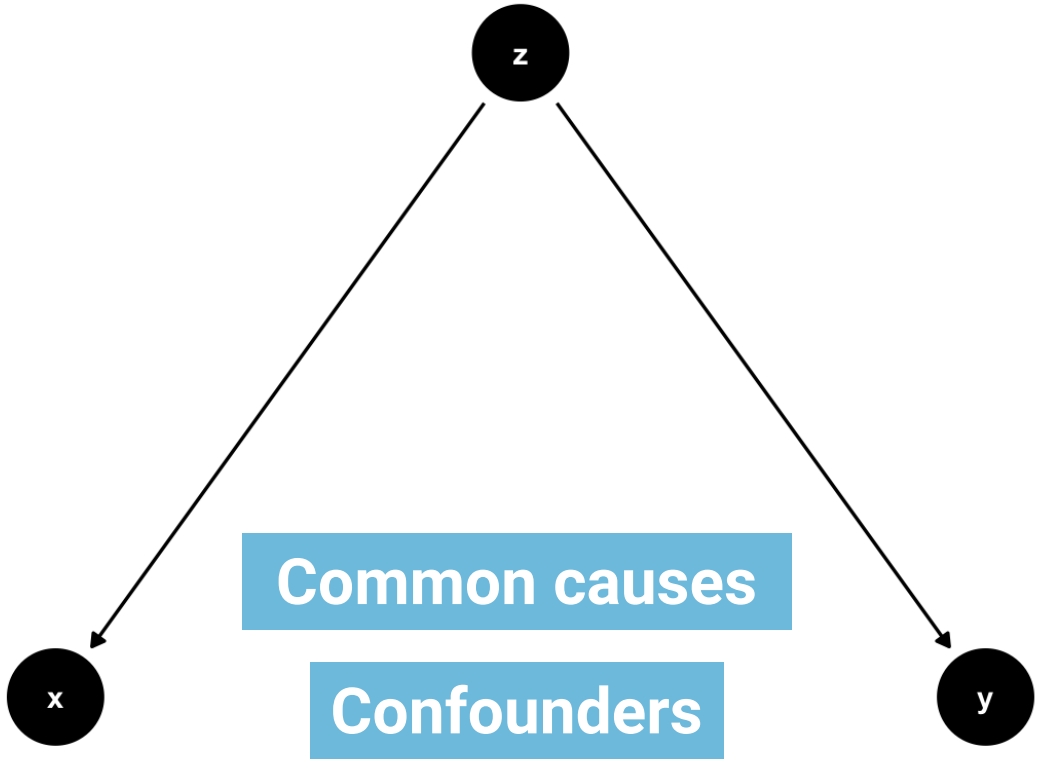
What would happen if we controlled for drug use?



adjusted unadjusted

adjusted adjusted unadjusted

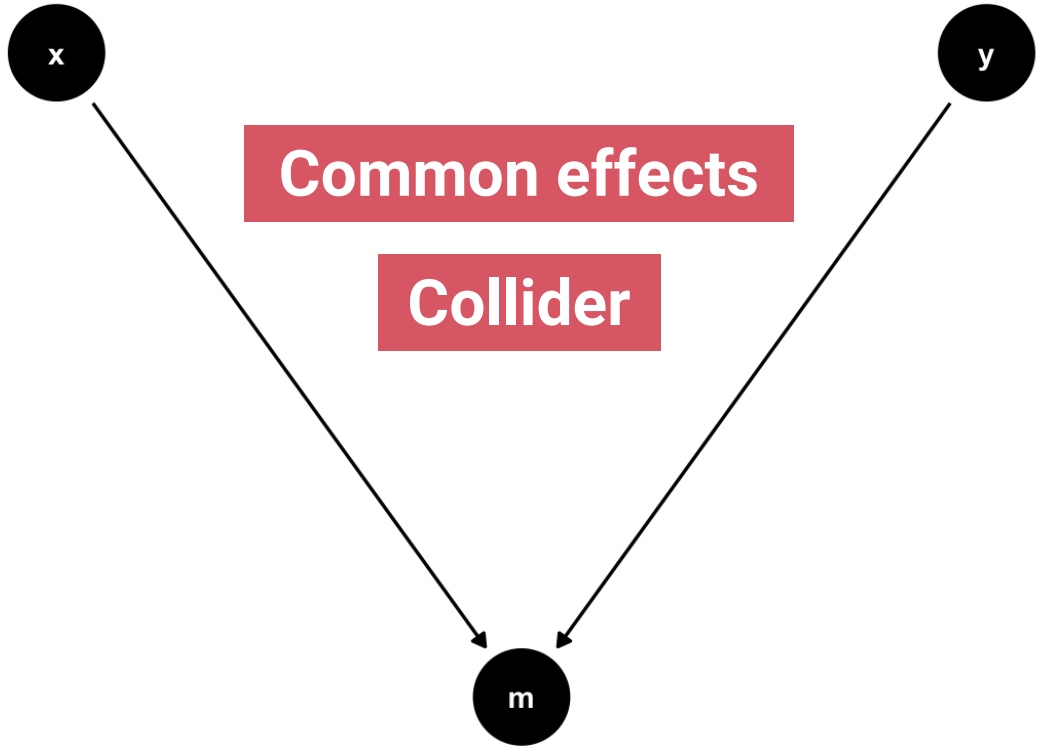
OVERCONTROLLING AND COLLIDERS



Common causes

Confounders

Control for these



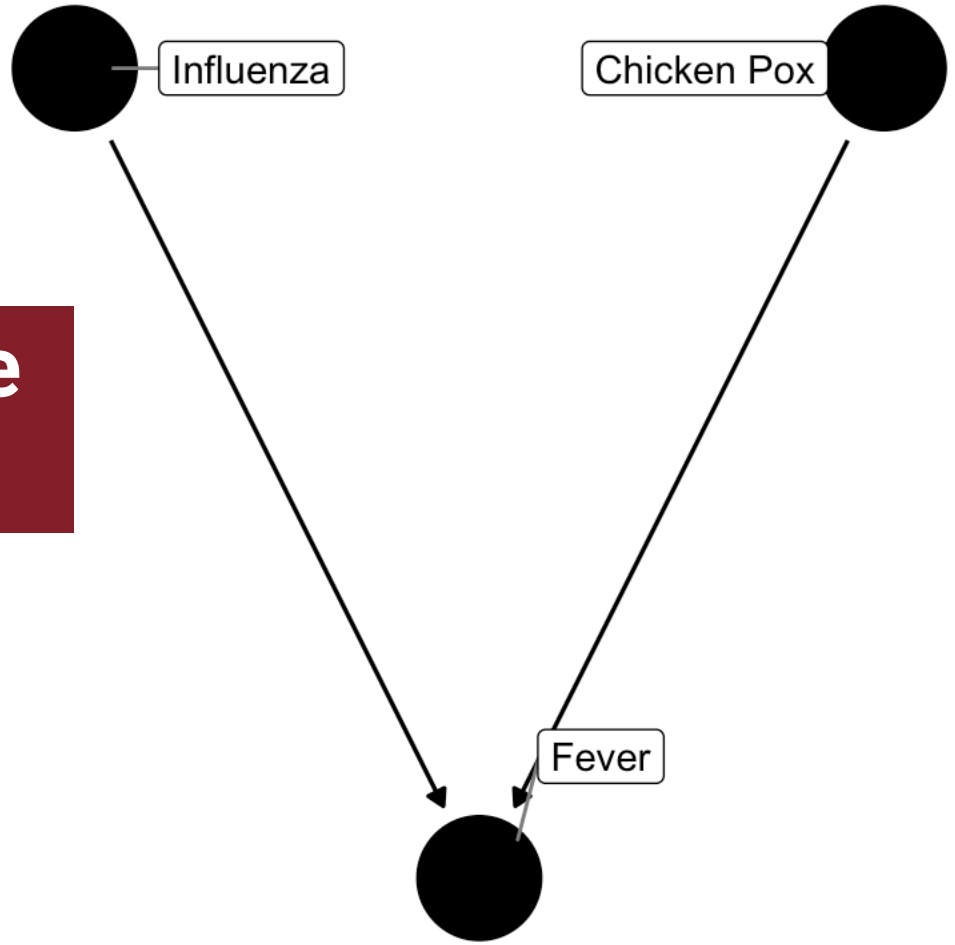
Common effects

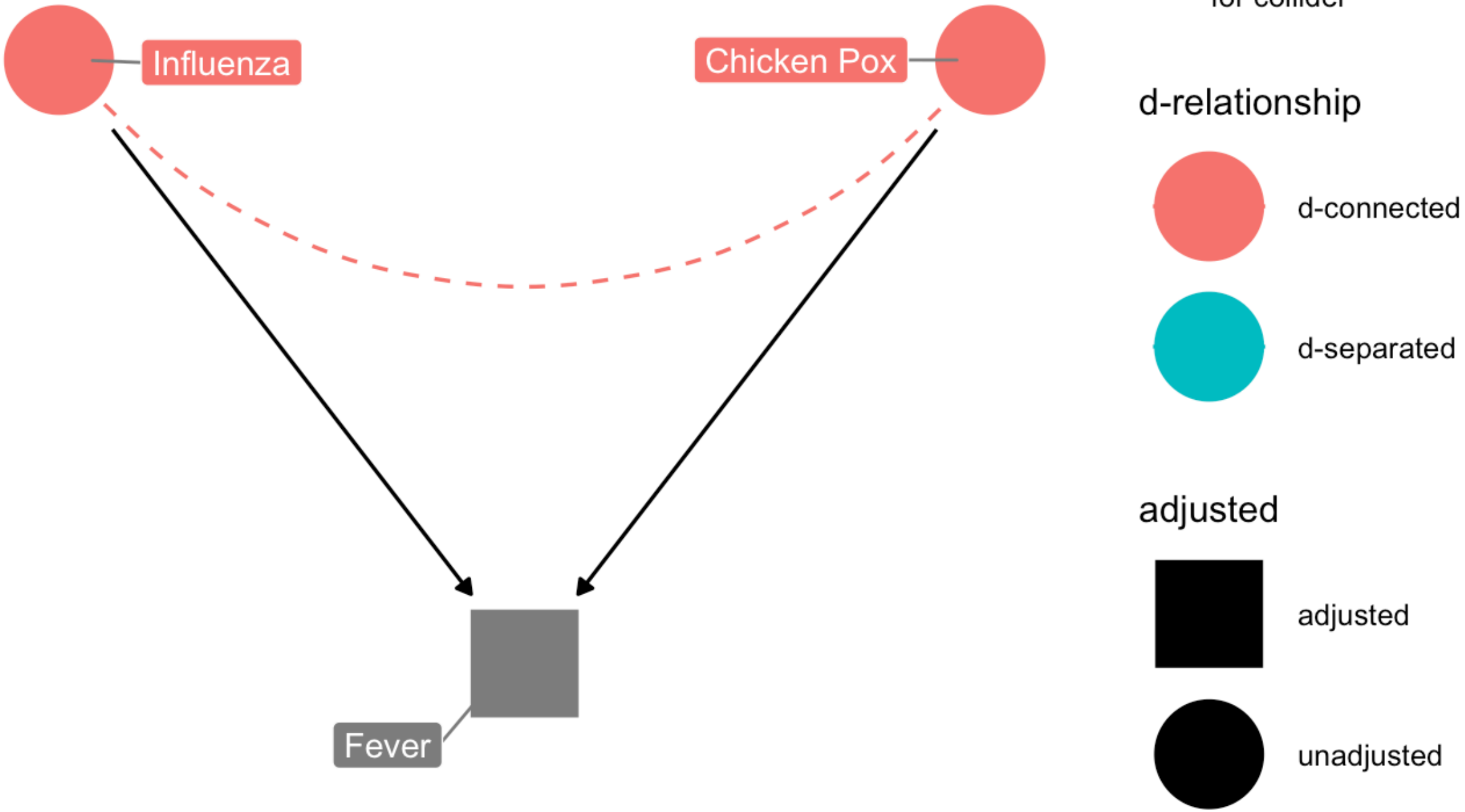
Collider

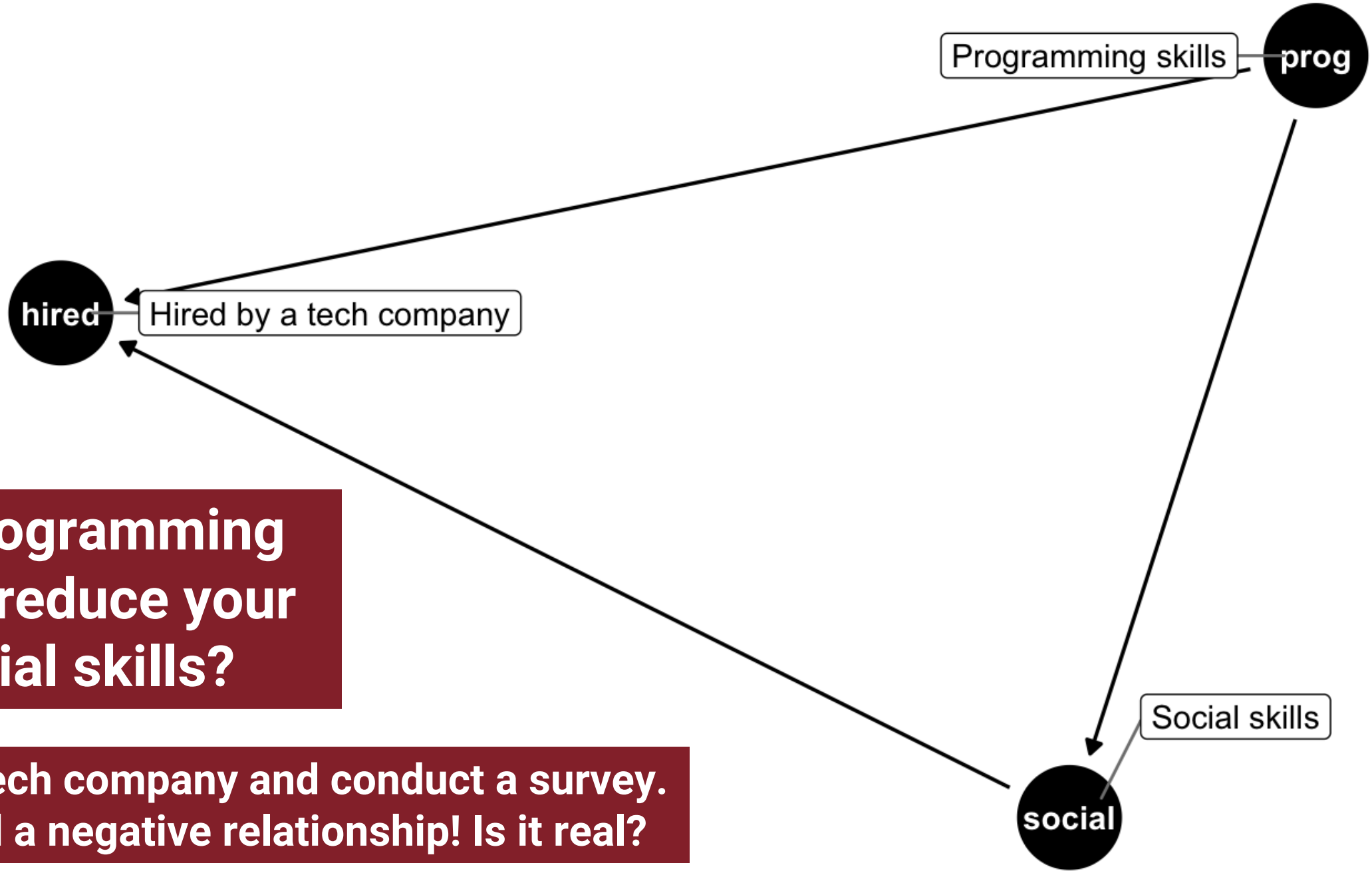
Don’t control for M

OVERCONTROLLING AND COLLIDERS

Does the flu cause chicken pox?

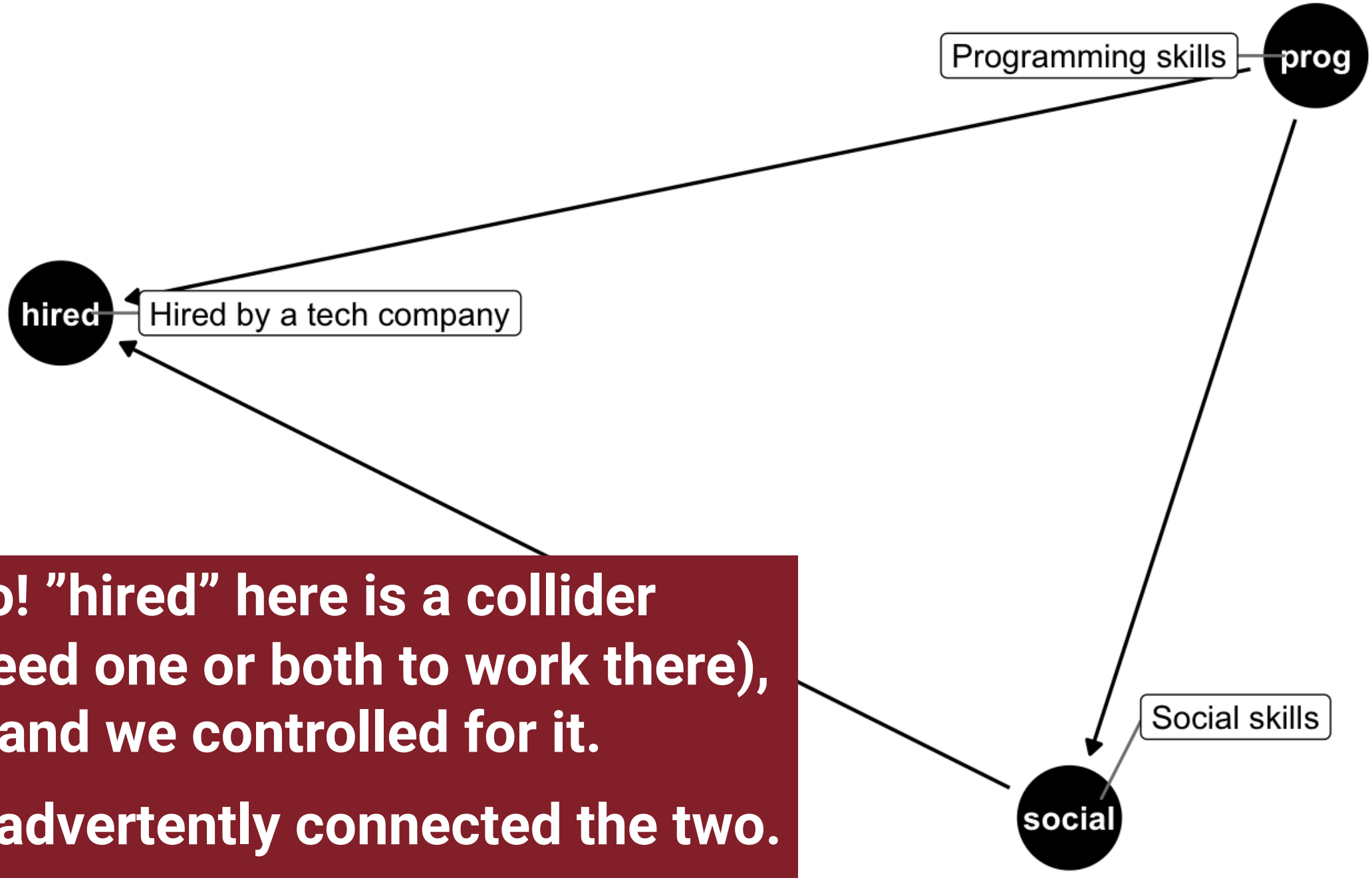



activated by
adjustment
for collider
Influenza
Chicken Pox
Fever
d-relationship
d-connected
d-separated
adjusted
adjusted
unadjusted



Do programming skills reduce your social skills?

Go to a tech company and conduct a survey. You find a negative relationship! Is it real?



No! ”hired” here is a collider (you need one or both to work there), and we controlled for it.

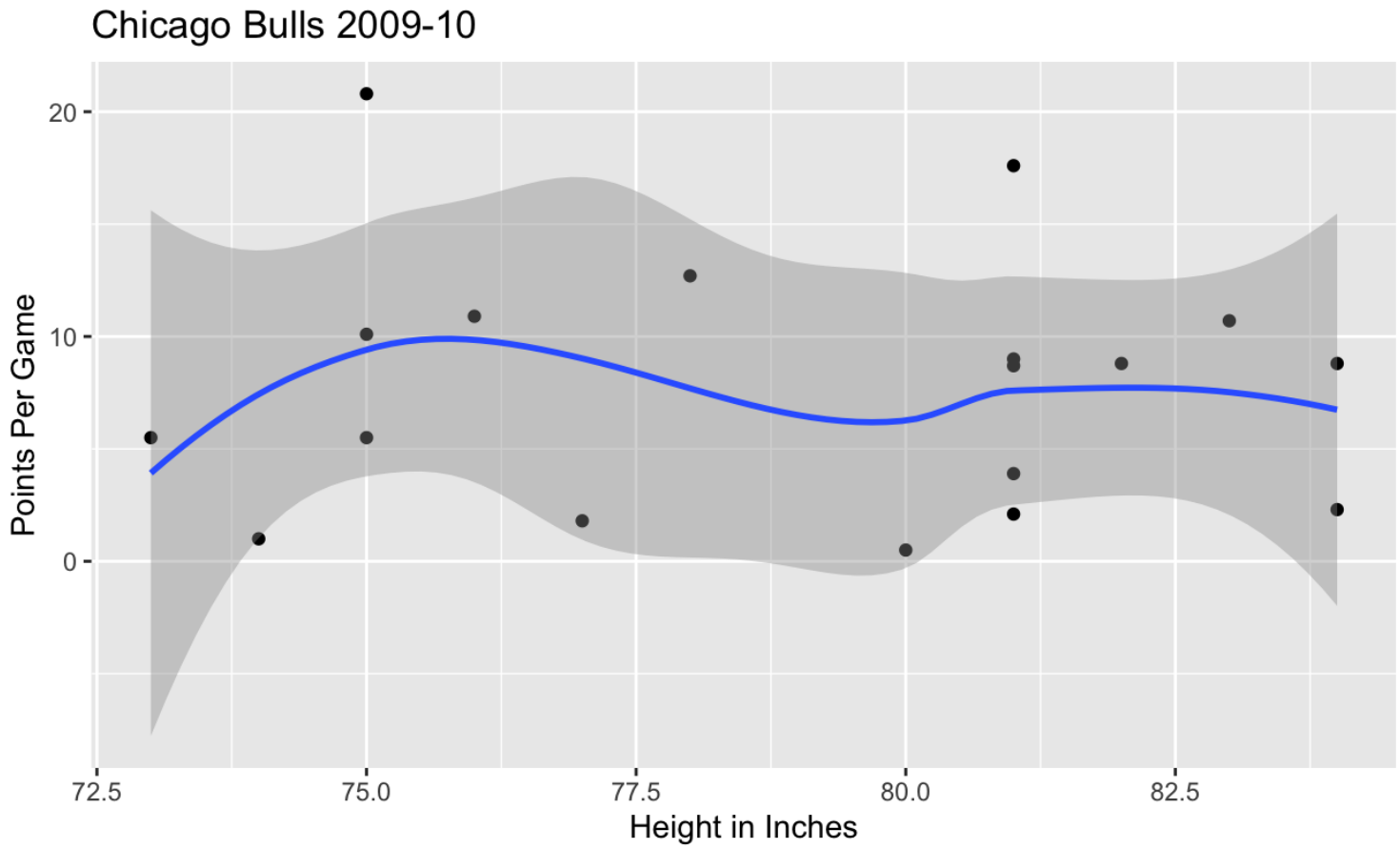
That inadvertently connected the two.

Colliders can create fake causal effects

Colliders can hide real causal effects

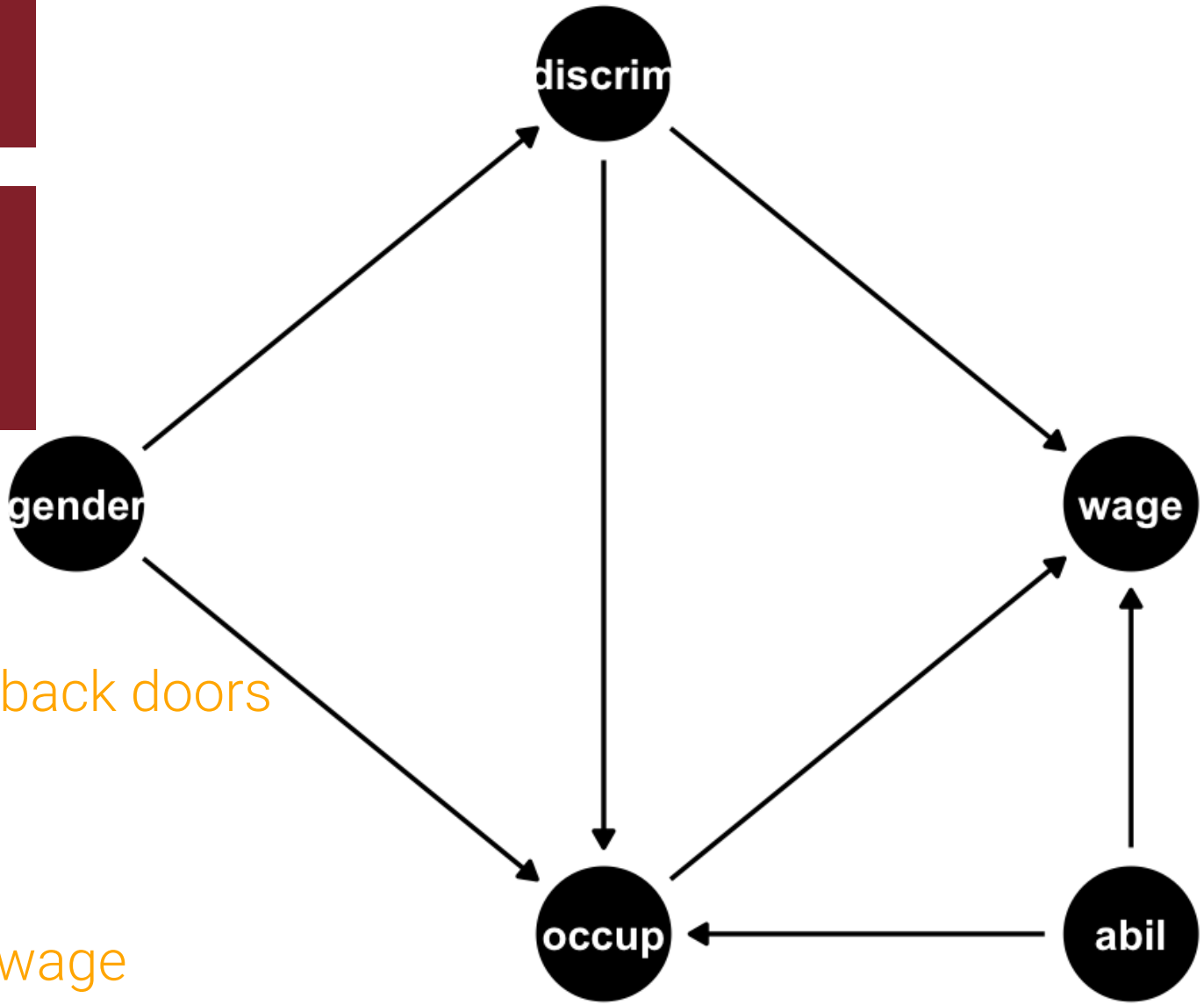
Height is unrelated to basketball skill!

...among NBA players



Interested in effect of gender → discrimination → wage

Should you control for occupation?



Front doors/Open back doors/Closed back doors

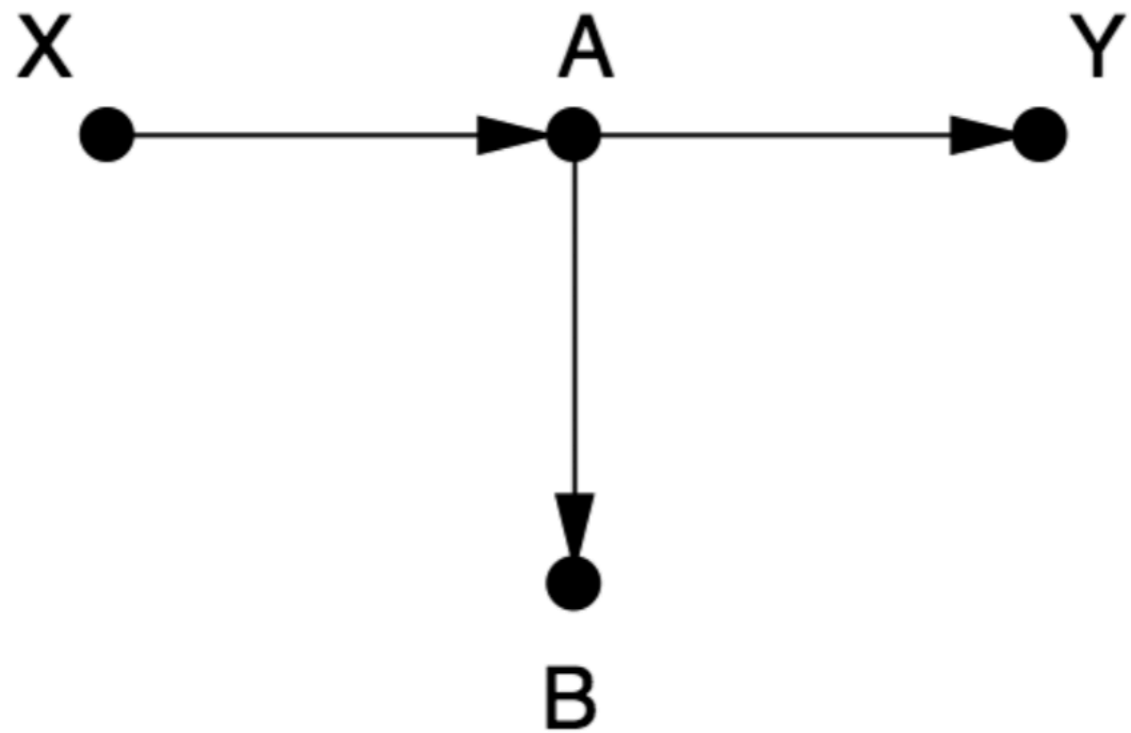
gender → discrim → wage

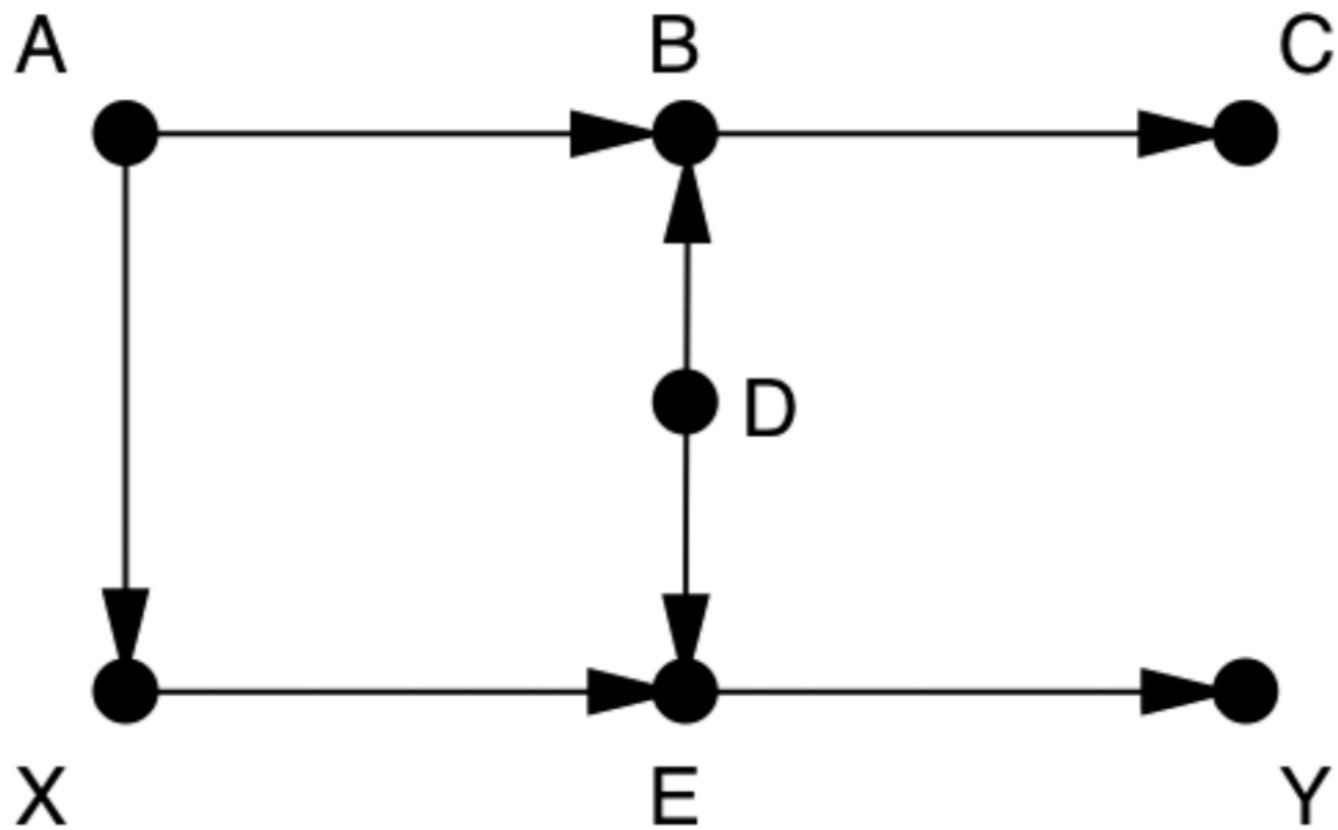
gender → discrim → occup → wage

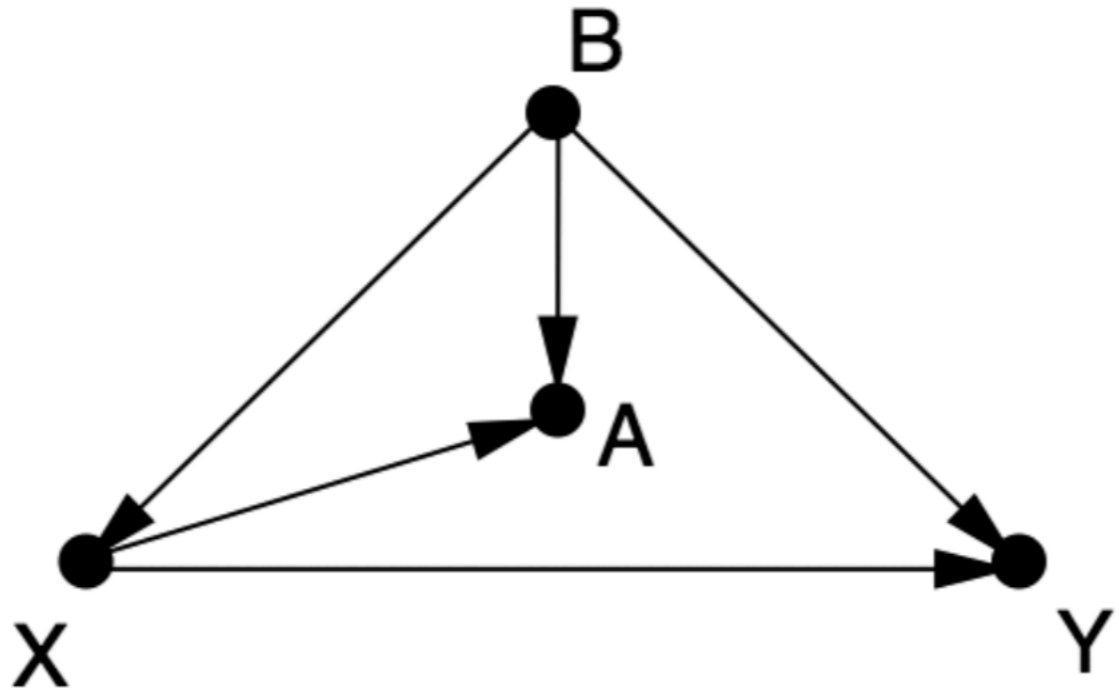
discrim ← gender → occup → wage

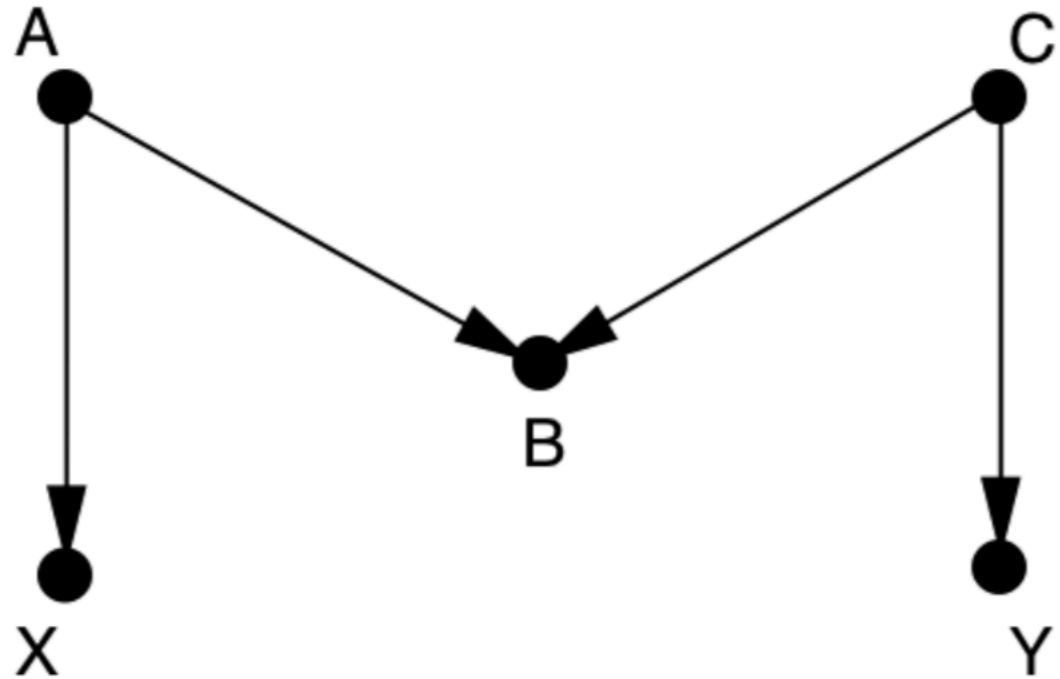
discrim ← gender → occup ← abil → wage

gender → discrim → occup ← abil → wage


X
A
Y
B


A
B
C
D
X
E
Y


B
A
X
Y


A
C
B
X
Y

POTENTIAL OUTCOMES

Next time!

ATE

ATT (TOT)

ATU (TUT)

QUESTIONS