

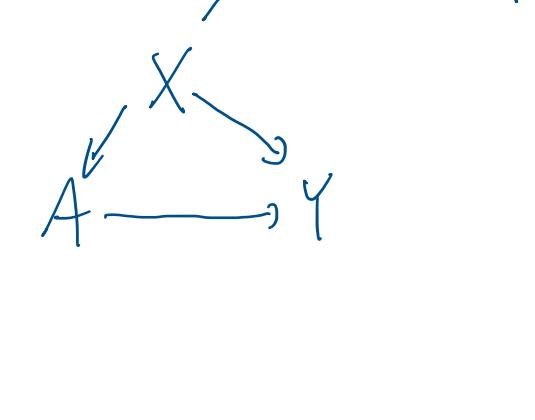
## Confounding revisited

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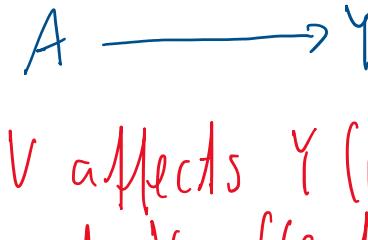
- Content:
  - front-door paths & back-door paths
  - understand why back-door paths need to be blocked

### Reminder confounder:

- a variable affecting both, treatment A and outcome Y :



Now: Consider more complex case:



↳ V affects Y (indirectly, through its effect on W) and V affects A (directly)

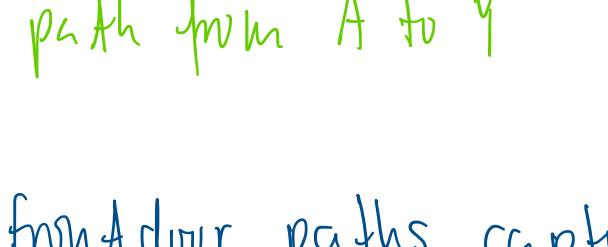
what matters is not identifying specific confounders, but identifying the set of variables that are sufficient to control for confounding.

↳ to do this we need to block backdoor paths from treatment A to outcome Y.

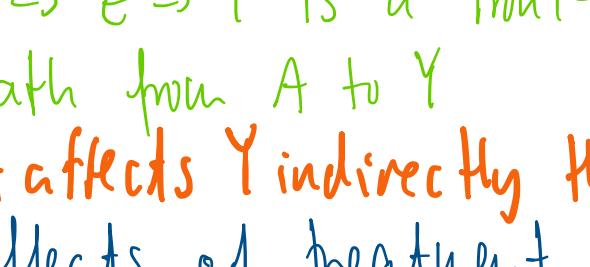
### What is a frontdoor path:

- a path from A to Y that begins with an arrow emanating out of A

↳ ex.:



$A \rightarrow Y$  is a front-door path from A to Y



$A \rightarrow Z \rightarrow Y$  is a front-door path from A to Y

• arrow flowing out of A is key property of frontdoor paths

↳ A affects Y indirectly through its effect on Z.

- front-door paths capture the effects of treatment A on outcome Y.

- we do not want to control for variables in the front-door path

↳ if we are interested in the effect of A on Y, we should not control for [block] fix Z in the path

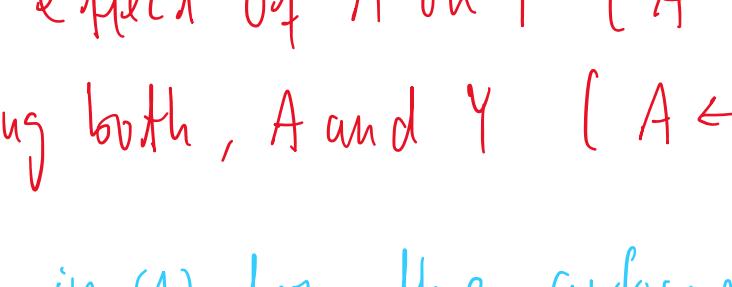
⇒ controlling for Z would be controlling for an effect of treatment.

(Causal mediation analysis : involves understanding front-door paths from A to Y).

↳ quantifies how much of the effect of treatment is through intermediate variables (i.e. mediators)

### What is a backdoor path?

Backdoor paths from treatment A to outcome Y are paths from A to Y that travel through arrows going into A:



( $A \leftarrow X \rightarrow Y$  is the backdoor path from A to Y).

- this path is worrisome b/c A and Y are associated through that backdoor path

↳ the marginal association btw. A and Y will be due to both paths, namely

goal: to separate {  
out the  
actual treat-  
ment effect  
(1) causal effect of A on Y ( $A \rightarrow Y$ : front-door path)  
(2) X causing both, A and Y ( $A \leftarrow X \rightarrow Y$ : backdoor path)}

association in (1) from the confounding effect in (2)

⇒ in general: backdoor paths confound the relationship btw. A and Y

↳ thus: we wish to block these treatment-effect-unrelevant paths of association between A and Y.

GOAL of treatment effect estimation:

⇒ to identify the set of variables X, that block all of the backdoor paths from treatment A to outcome Y!

↳ in doing so, we sufficiently control for confounding

⇒  $Y^0, Y^1 \perp\!\!\!\perp A | X$  : is true when we eliminate all backdoor paths. (block)

(ignorability of treatment mechanism given X)

⇒ X is the set of variables that blocks all backdoor paths (i.e. X is sufficient to control for confounding)!

⇒ there are 2 criterions needed for identifying this set of variables X that are sufficient to control for confounding. (next lectures).