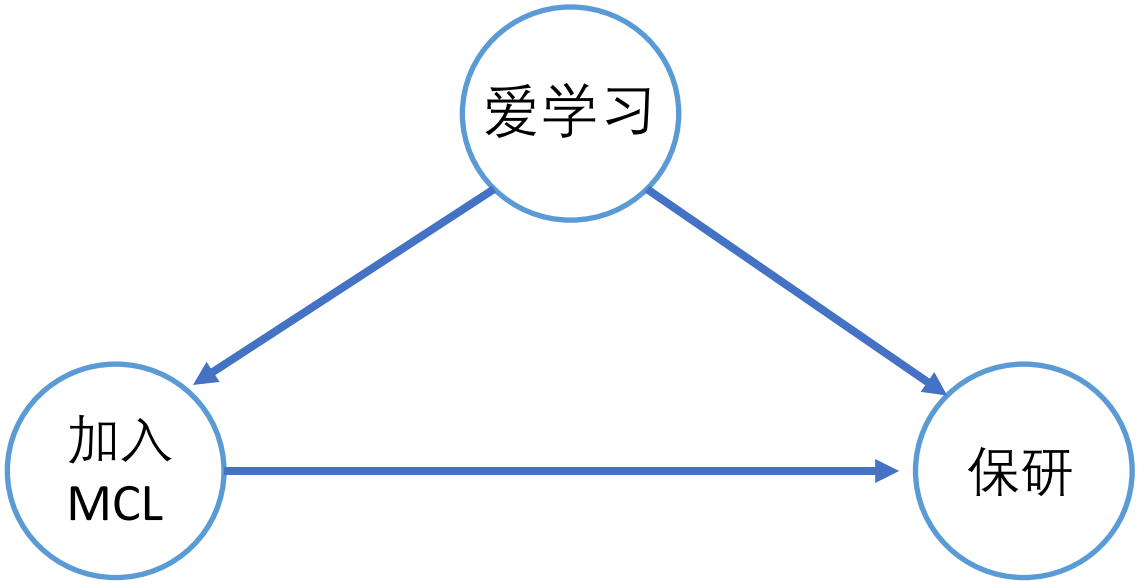
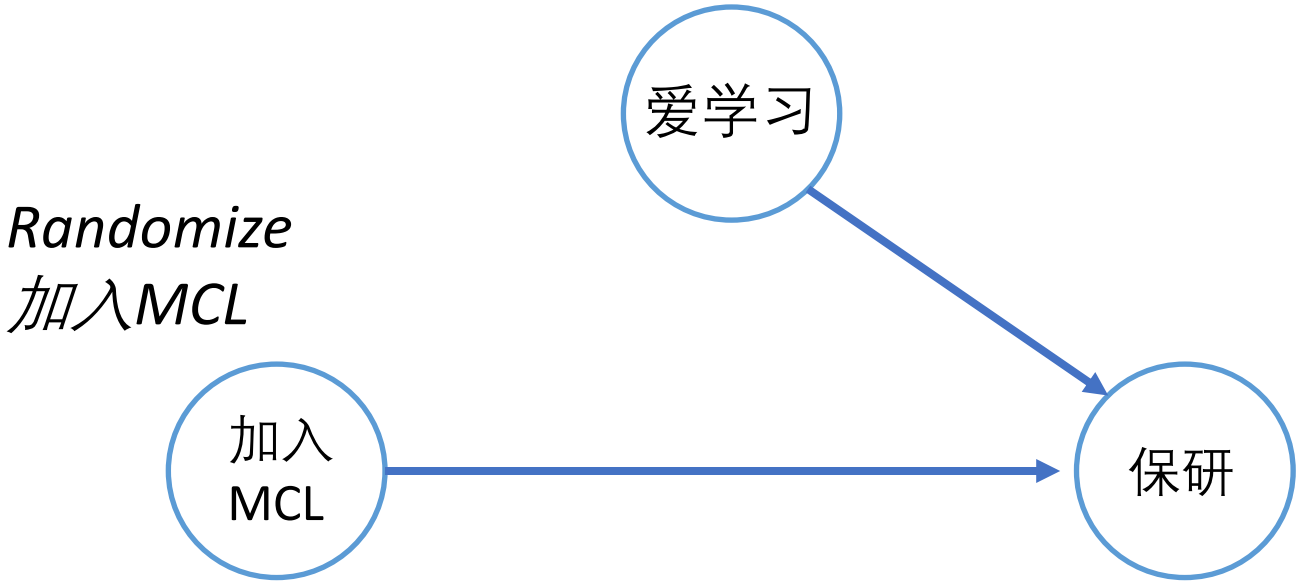
5. Randomized Experiment



Target of randomized experiment:

Keeping the same distribution of all confounders the same irrespective of different treatment.
(Covariate Balance)

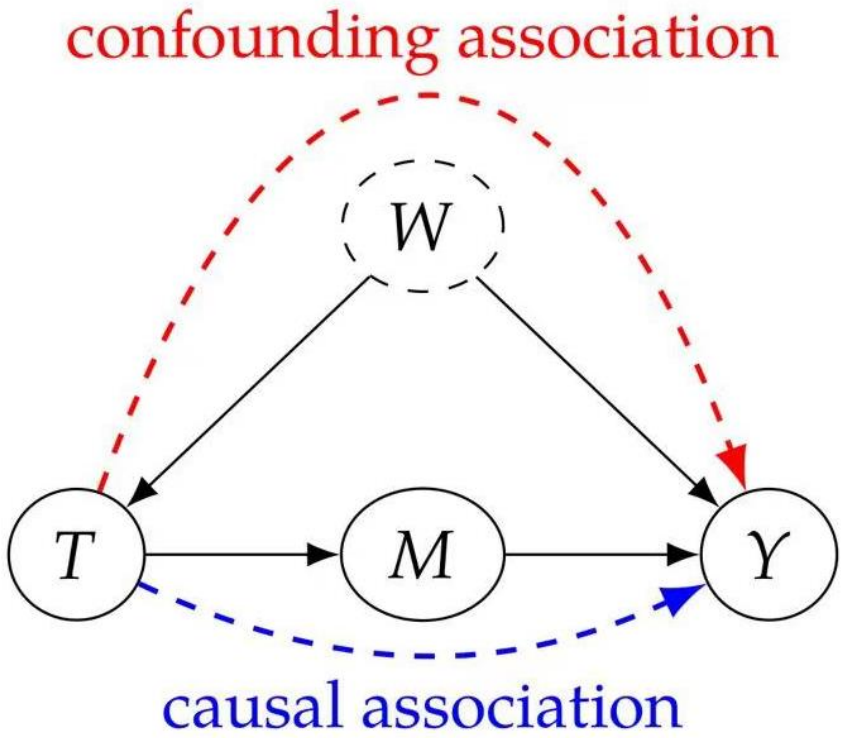


$$P(保研|do(加入MCL)) = P(保研|加入MCL)$$

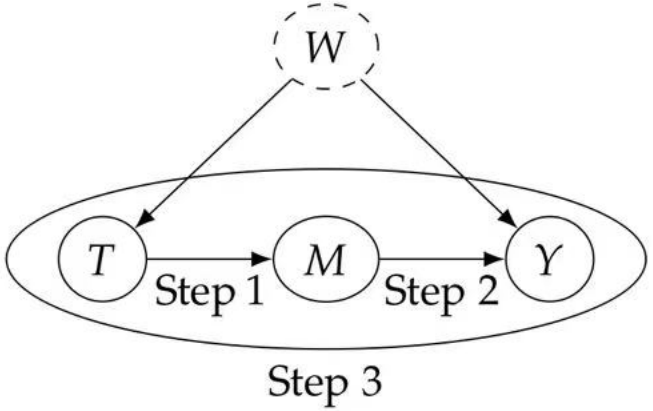
Condition can be used instead of **do()** operation given **covariate balance.**

6. Frontdoor Adjustment

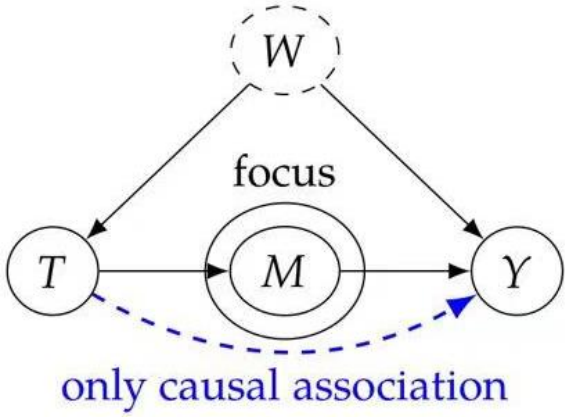
Why using frontdoor adjustment?



Unobserved confounders make it not available to use backdoor adjustment



What if we combine the causal effect from T to M and form M to Y since both of them are **purely causal**.

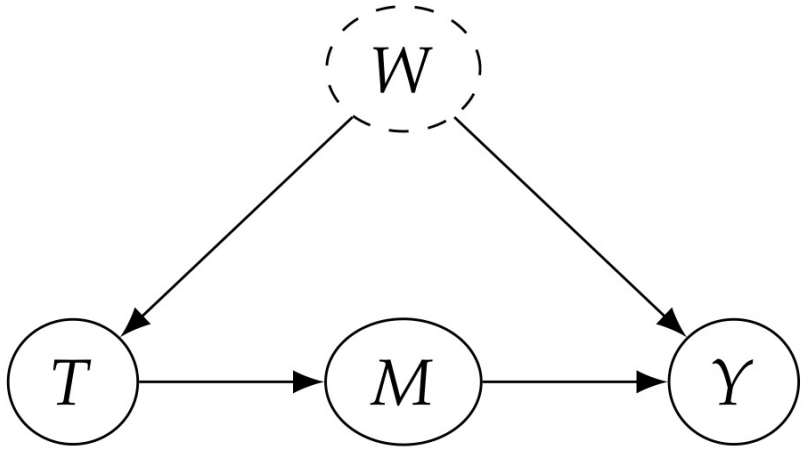


This method is called frontdoor adjustment.

Frontdoor adjustment:

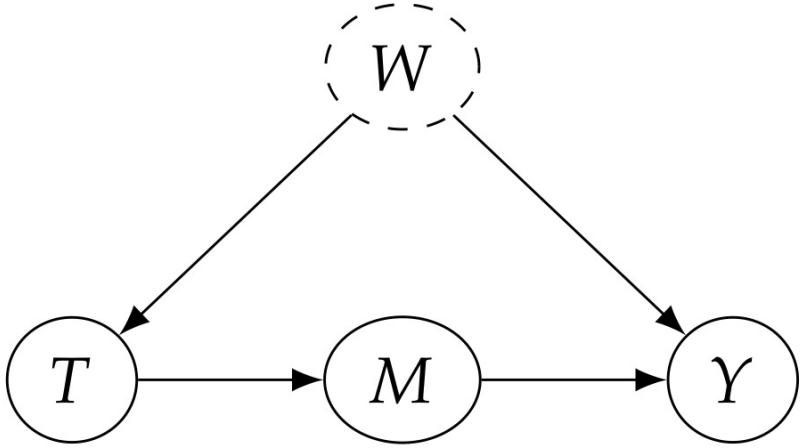
Theorem 6.1 (Frontdoor Adjustment) *If* (T, M, Y) *satisfy the frontdoor criterion and we have positivity, then*

$$P(y \mid do(t)) = \sum_{m} P(m \mid t) \sum_{t'} P(y \mid m, t') P(t') \qquad (6.4)$$

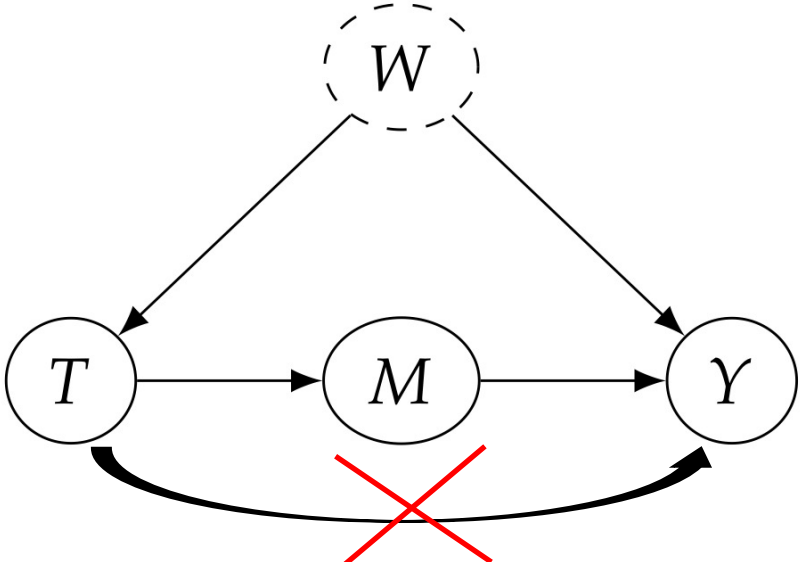


Using **M** to do frontdoor adjustment from **do(T=t)** to **Y**

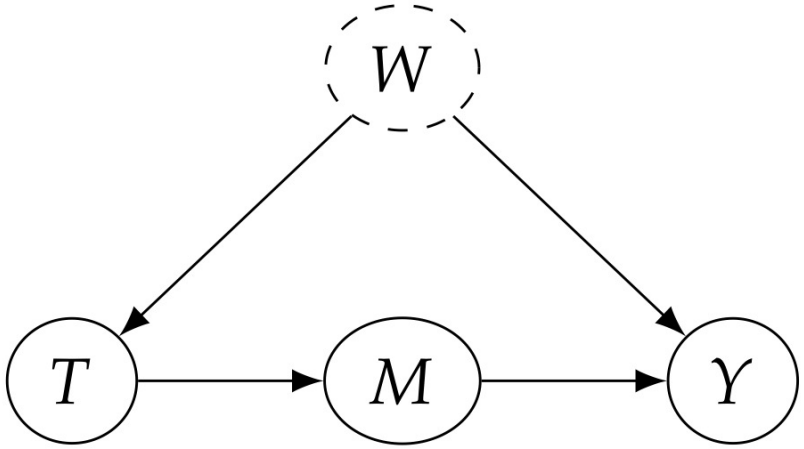
Limitation:



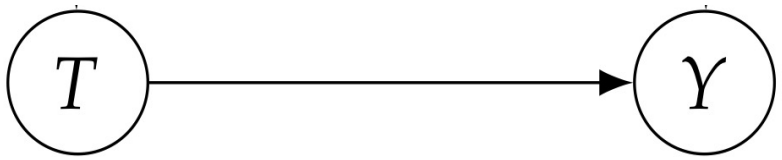
1. All the causal path from T to Y must go via M.
   (M must be the totally frontdoor between T and Y).



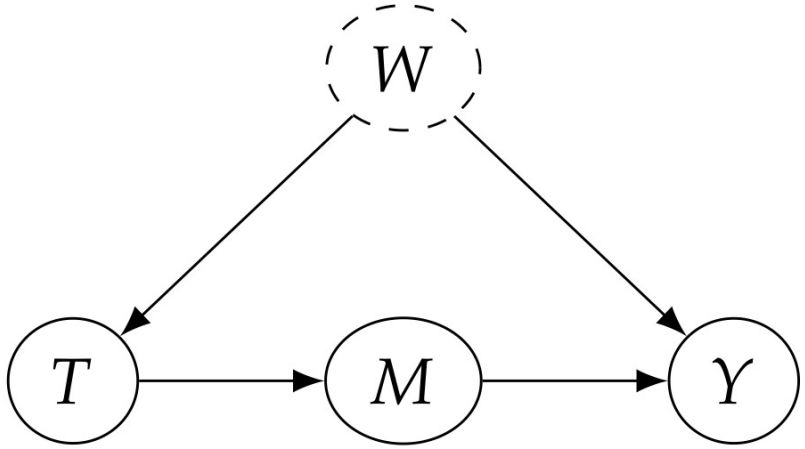
2. The relation flow from T to M must be purely causal.



P(m| t) = P(m | do(t)) needed to use frontdoor adjustment.



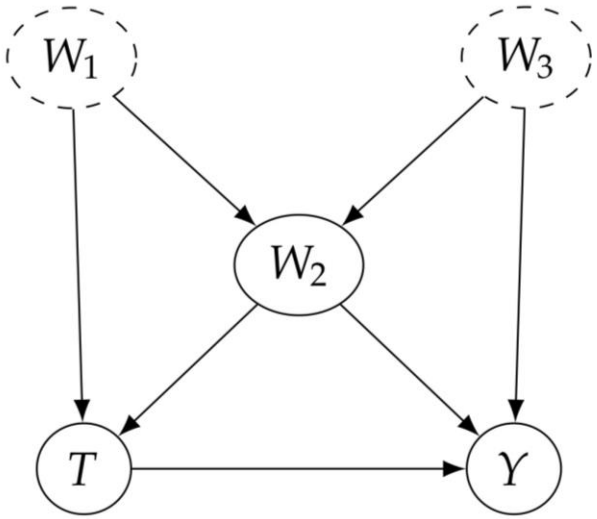
3. T is available for backdoor adjustment from M to Y.



Proof of frontdoor adjustment.

Now that we know frontdoor adjustment and backdoor adjustment can **change causal estimator to statistics estimator**

But, how can we be sure that a variable is *identifiable*?



Is P(y | do(t)) identifiable?

Theorem 6.3 (Unconfounded Children Identifiability) *Let Y be the set of outcome variables and T be a single variable. If the unconfounded children criterion and positivity are satisfied, then $P(Y = y \mid do(T = t))$ is identifiable*

Definition 6.2 (Unconfounded Children Criterion) *This criterion is satisfied if it is possible to block all backdoor paths from the treatment variable T to all of its children that are ancestors of Y with a single conditioning set.*