Pre-treatment colliders: Extending the Hollywood example

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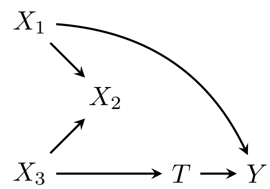
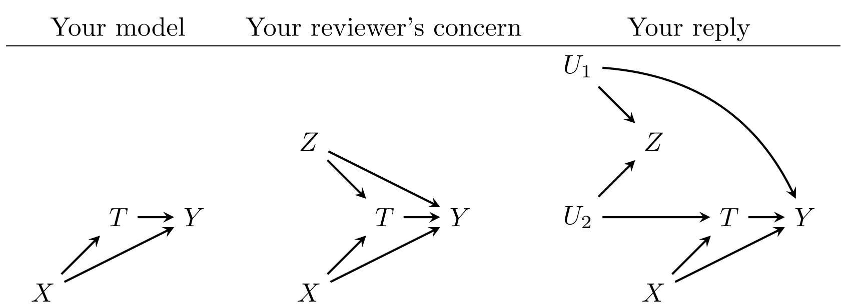
In precept, I gave the following example of a pre-treatment collider X_2 that blocks the backdoor path from T to Y.



Someone asked for a substantive example of this. I think we can extend our Hollywood example to this case. I changed the variable letters below to make it clear what is observed and unobserved. Suppose that

- T is marriage
- Y is happiness
- X is one's parents' marital status
- U_1 is acting ability
- U_2 is beauty
- Z is acting in Hollywood movies



Your model

You want to show that marriage (T) leads to happiness (Y). However, you are worried that one's parents' marital status (X) is a **confounder**: it is a common cause of both marriage and happiness. In other words, people whose parents are married are both more likely to be married themselves because they follow their parents' example, and they are happier because their parents are married.

You claim that, net of parents' marital status, potential happiness $\{Y_i(0), Y_i(1)\}$ is independent of treatment assignment T. This is a claim of **conditional ignorability**.

You claim that, under this assumption, you have **identified** the causal effect of marriage on happiness.

Your reviewer

Your reviewer likes reading the tabloids and suggests that being a Hollywood actor (Z) will make someone really happy (Y), and might also affect their marriage probability (T). Thus, Z **is a confounder you failed to condition on**, and your estimate is really the sum of the unblocked backdoor path $T \leftarrow Z \rightarrow Y$ and the causal path $T \rightarrow Y$.

Without conditioning on whether the respondent works in Hollywood films, **your reviewer argues that your causal estimate is biased**. Under the reviewer's theory, this argument is correct. You should condition on Z.

Your response

You respond with a different theory. You say that unobserved beauty (U_2) affects Hollywood acting (Z) and marriage (T). You tell the reviewer that Hollywood acting (Z) and marriage (T) are only related because they are both caused by beauty (U_2). Likewise, Hollywood acting (Z) and happiness (Y) are only related because they are both caused (directly or indirectly) by beauty (U_2), and beauty (U_2) only affects happiness through its effect on marriage. Thus, it is unnecessary to condition on Z, since Z does not affect Y.

Further, you argue that controlling for Hollywood acting would actually *induce* bias in your estimated effect of T on Y because you argue that Z is a **collider**. Unobserved acting ability (U_1) affects Hollywood acting and happiness - people who are good actors have a fun passion that makes their lives enjoyable! Controlling for Hollywood acting (Z) creates a non-causal association between acting ability (U_1) and beauty (U_2), thereby unblocking a backdoor path $T \leftarrow U_2 \leftrightarrow U_1 \rightarrow Y$ that was previously blocked. **By controlling for Hollywood, you argue that the estimates will be worse than without controlling for it.**

What does this crazy example show?

Whether you should condition on Hollywood acting (Z) depends on your **theory** about how all the variables are causally related. By drawing the DAG, it becomes easier for you and the reviewer to distinguish how your theories differ, and why they imply different identification strategies.

Want more examples?

Look in the Elwert and Winship (2014) paper (link here)! They walk through a ton of these to build intuition for different ways collider conditioning bias can creep into our studies. Figure 12 shows this particular problem in social network analysis, and Figure 13 walks through why the data can't distinguish between the stories without a theory. The Hollywood example (before my extensions) is on p. 36.