Homework for Chapter 8: Causal Paths

1. Assuming that a path has no colliders on it, what is the difference between a path being Open and Closed?

There is variation in all variables along the Open path while there is at least one variable with no variation along the Closed path.

1. Consider the below generic causal diagram.  
   Diagram, shape

   Description automatically generated
   1. List every path from X to Y.

X->A->Y

X->C<-D->Y

X<-B->Y

X<-B<-D->Y

X->C<-D->B->Y

* 1. Which of the paths are front-door paths?

X->A->Y

* 1. Which of the paths are open back-door paths?

X<-B->Y

X<-B<-D->Y

* 1. What variables must be controlled for in order to identify the effect of X on Y? (only list what *must* be controlled for, not anything that additionally *could* be controlled for).

B

1. Consider the research question: Does having higher income cause better health?
   1. Draw a causal diagram depicting the data generating process for this relationship with 5-10 variables on it.

Access to Medical Resource

Health

Income

Living Conditions

Unemployment

Pandemic

* 1. Identify the Front Door paths.

Income->Access to Medical Resource->Health

Income->Living Conditions ->Health

* 1. Identify the Back Door paths.

Income<-Unemployment<-Pandemic-> Health

* 1. Identify the paths that represent direct effects.

There is no direct effect of Income on Health on the diagram, but Pandemic has a direct effect on Health (Pandemic-> Health).

* 1. Identify the Good Paths and the Bad Paths.

Good Path: Income->Access to Medical Resource->Health

Income->Living Conditions ->Health

Bad Path: Income<-Unemployment<-Pandemic-> Health

1. Which of the following describes a causal path where all the arrows point away from the treatment? c
   1. Open Path
   2. Closed Path
   3. Front Door Path
   4. Back Door Path
2. Consider the figure below, which depicts the relationship between teaching quality, number of publications (e.g., articles, books), and popularity among scholars and students in a population of professors.  
   Line chart

   Description automatically generated
   1. What type of variable is Popularity in one path on this diagram?

Collider.

* 1. Discuss what would happen if you controlled for Popularity.

If we controlled for the collider Popularity, the two variables pointing to the collider Teaching Quality and Number of Publications would become related, which might open back up a closed path and produce the alternate explanation(s).

1. Consider the figure below, which depicts the relationship between a pandemic-related lockdown and an economic recession. The research question of interest is: Does a pandemic-related lockdown cause recession?   
   A picture containing text, antenna, line

   Description automatically generated
   1. Write down all the paths in the diagram from Lockdown to Recession. To make our lives simpler (there are a lot of paths in this diagram), ignore any path that goes through Stimulus.

Lockdown->Recession

Lockdown->Unemployment->Recession

Lockdown->Unemployment<- PriorEconomy-> Recession

Lockdown<-PriorEconomy-> Recession

Lockdown<-PriorEconomy-> Unemployment-> Recession

* 1. List all of the paths that are Front Door Paths.

Lockdown->Recession

Lockdown->Unemployment->Recession

* 1. What would happen if we controlled for unemployment?

The once open paths involving Unemployment will be closed because one of the variables (Unemployment) along those paths has no variation after being controlled for.

* 1. Is it possible to measure each of the variables adequately?

Lockdown and Unemployment can be measured based on data of lockdown timing and unemployment rate from official websites and documents. It is possible yet hard to measure PriorEconomy and Recession through economic metrics such as Consumer Price Index (CPI), Gross domestic product (GDP), and stock markets. Also, the Stimulus can be difficult to statistically measure and estimated adequately.

* 1. Can you think of any variables and paths not depicted in the diagram that may be relevant to identify the answer to the research question? List at least one and no more than three.

Lockdown->Consumer Spending ->Recession

PriorEconomy-> Consumer Spending ->Recession

PriorEconomy-> Stimulus->Consumer Spending ->Recession

1. Consider the question: Does obtaining a higher education improve income? Think of a couple of examples of Bad Paths in a causal diagram depicting the data generating process for this research question.

Education<-Family Background->Social Capital->Income

Education<- Initial Career Choice->Income (Some careers require higher education degrees for entry than others - people are motivated to pursue a relevant degree to get a job in the certain professional field that they are interested in at the first place - and jobs in those careers happen to be or become well paid)

Education<- College Admission<-Practical Experience->Job Hunting ->Income

Education<- Personal Competence->Income