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?

Answer: A path is regarded as open if all of the variables along that paths are allowed to vary. A path is regarded as closed if at least one of the variables along that paths has no variation.

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

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

1.X→A→Y

2.X←B→Y

3.X←B←D→Y

4.X→C←D→Y

5.X→C←D→B→Y

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

Answer: 1. X→A→Y (This is a front-door path)

Both the second the third paths are back-door paths. Both the forth and the fifth paths are potential back-door paths with a collider, C, and controlling for C will open the gate.

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

Answer: 2.X←B→Y

3.X←B←D→Y

Both the second and the third path are open back-door paths.

* 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).

Answer: 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.

图示

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* 1. Identify the Front Door paths.

Answer:

Income→Health

Income→Wine→Health

Income→HealthCareQuality→Health

* 1. Identify the Back Door paths.

Answer: Income←Age→Health

Income←Gender→Health

Income←ResidenceCountry→Health

* 1. Identify the paths that represent direct effects.

Answer: The direct effects between treatment and outcome is Income→Health.

The other direct effects in this diagram:

Income→Wine

Wine→Health

Income→HealthCareQuality

HealthCareQuality→Health

Age→Income

Age→Health

Gender→Income

Gender→Health

ResidenceCountry→Income

ResidenceCountry→Health

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

Answer: Good Paths: Income→Health

Income→Wine→Health

Income→HealthCareQuality→Health

Bad Paths: Income←Age→Health

Income←Gender→Health

Income←ResidenceCountry→Health

1. Which of the following describes a causal path where all the arrows point away from the treatment? Answer: c. Front Door Path.
   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?

Answer: It is a collider variable among the path, Teaching Quality→Pouplarity←NumberOfPublications. It is also an unobserved variable.

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

Answer: If we control for Popularity, the path will open and the two variables, TeachingQuality and NumberOfPublications will become related.

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.

Answer:

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.

Answer: Lockdown →Recession

Lockdown →Unemployment→ Recession

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

If we control for unemployment, we will first miss the effect on Lockdown on Recession via Unemployment, which is related to our research question; and open the potential backdoor path, Lockdown→ Unemployment← PriorEconomy→ Recession

, making Lockdown and PriorEconomy become related.

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

I do not think that it is possible to measure each of the variables adequately. For example, we might not immediately get the unemployment data just after/during the pandemic because it takes some time to collect unemployment data over the country. Besides, the Stimulus variable might be an unobserved variable. As for the prioreconomy variable, we might need to decide which aspect/index we want to use to describe the economy, which means that it is hard to cover every aspect of economy.

* 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.

The number of infected people might be relevant to identify the answer to the research question. The number of infected people will affect whether there should be a lockdown and the more people get infected, the economy is more likely to experience a recession. So the number of infected people could be an alternative explanation of the correlation between a pandemic-related lockdown and an economic recession. So we need to consider this variable and toss out this alternative explanation to identify the answer to the research question.

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.

Answer:

Bad paths:

Education← ParentsDegree→ Income

Education ←Gender→ Income

Education ←Gender→ TypesOfJobs →Income

图示

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