

## Philosophy 12: Introduction to Causal Reasoning

### Answers to study questions for Lecture 4: “Causal Graphs”

For questions 1 through 4, use the response structure for the malaria example found in the course notes.

1. Which of the following pairs of causal assignments do we need to compare to see whether INOCULATED is a direct cause of MALARIA? (Note: not all of the pairs we need to check are on this list.)

- (a) Assignments 1 and 3
- (b) Assignments 2 and 6
- (c) Assignments 4 and 7
- (d) Assignments 9 and 13

The reason (a) isn't correct is that in causal assignments 1 and 3, everything except HAS GENE is held constant, but we're trying to find out whether INOCULATED is a direct cause of MALARIA. Choice (c) is incorrect because in assignments 4 and 7, INOCULATED does change, but so does DRINKER. To find out whether INOCULATED is a direct cause of MALARIA, we have to hold all the possible causal factors except INOCULATED constant.

2. Should there be a directed edge from INOCULATED to MALARIA?

- (a) Yes
- (b) No

Try looking at causal assignments 3 and 6, or 4 and 7. In each of these pairs, INOCULATED is the only variable that changes, and MALARIA also changes values. Therefore, INOCULATED is a direct cause of MALARIA.

3. Which pairs of causal assignments should we compare to determine whether DRINKER is a direct cause of MALARIA?

- (a) Assignments 1 and 2
- (b) Assignments 15 and 16
- (c) Assignments 5 and 7
- (d) Assignments 11 and 12

The reason (c) is not correct is that in assignments 5 and 7, DRINKER doesn't change, but HAS GENE does.

4. Should there be a directed edge from DRINKER to MALARIA?

- (a) Yes
- (b) No

Remember that we only include an edge from DRINKER to MALARIA if there is a pair of causal assignments in which we hold everything except DRINKER constant, and changing the value of DRINKER sometimes changes the value of MALARIA. There are no such pairs of causal assignments.

5. Causal graphs represent:

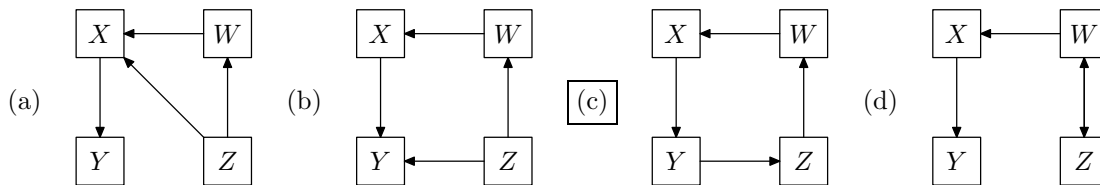
- (a) Event causation claims.
- (b) Variable causation claims.
- (c) Neither

6. If there is a directed edge in a causal graph from  $X$  to  $Y$ , then that means (choose the best possible answer):
- (a)  $X$  is a cause of  $Y$ .
  - (b)  $X$  is a cause of  $Y$  relative to the other variables in the graph.
  - (c)  $X$  is a direct cause of  $Y$ .
  - (d)  $X$  is a direct cause of  $Y$  relative to the other variables in the graph.
7. Consider the following causal system:

Causal Assignment	GENDER	EXPERIENCE	HIRED
1	Female	Yes	20%
2	Female	No	10%
3	Male	Yes	20%
4	Male	No	10%

If we drew a causal graph for the system:  $\{\text{GENDER, EXPERIENCE, HIRED}\}$  and used the response structure above, which variables should have a directed edge into HIRED?

- (a) GENDER
  - (b) EXPERIENCE
  - (c) Neither GENDER nor EXPERIENCE
8. In which of the following causal graphs is there an indirect cycle but no direct cycle?



9. Which of the following does a causal graph contain? (Choose all that apply.)

- (a) Causal assignments
- (b) Response structures
- (c) Variables
- (d) Directed edges

10. Consider the three variables HAS A CHIPPED TOOTH, PAIN, and TAKES ASPRIN. Using common sense, check all that apply:

- (a) There is a directed edge from TAKES ASPRIN to PAIN because taking aspirin reduces pain.
- (b) There is no directed edge from TAKES ASPRIN to PAIN because taking aspirin reduces pain.
- (c) There is a directed edge from PAIN to TAKES ASPRIN because being in pain causes you to take aspirin.
- (d) None of the above

Choices (a) and (c) are correct because each is a cause of the other (although it is clearly not an example of deterministic causation, since taking aspirin does not always reduce pain, nor does one always take aspirin when one is in pain).

11. Which of the following must be true if there is an edge from variable  $X$  to variable  $Y$ ?

- (a)  $X$  is part of a jointly sufficient set for  $Y$ .
- (b) Bringing about some value of  $X$  is individually sufficient for  $Y$ .
- (c) There is a test pair for  $X$  such that  $Y$  varies across the pair.
- (d) None of the above

Simply being part of a jointly sufficient set for  $Y$  doesn't make something a cause of  $Y$ . Once we have a jointly sufficient set of conditions for  $Y$ , which can add virtually anything else to the jointly sufficient set and it will still be jointly sufficient—without making the thing we added a *cause* of  $Y$ .

12. In which of the following situations should we add an edge from variable  $X$  to  $Y$  in a causal graph for a system including  $X$  and  $Y$ ?

- (a) Bringing about some value of  $X$  only changes  $Y$  by changing the value of another variable.
- (b) Bringing about some value of  $X$  is sufficient for bringing about some value of  $Y$ , no matter what values are assigned to the other variables in the system.
- (c)  $Z$  is a common cause of  $X$  and  $Y$ , and  $W$  is a common effect of  $X$  and  $Y$ .
- (d) Changing the value of  $X$ , while holding the other variables constant, changes the probability of  $Y$ .
- (e) None of the above

13. Suppose that we are considering a causal system that involves the variables  $X$ ,  $Y$ ,  $Z$ , and  $W$ . Which variables must we consider when deciding whether  $X$  is a direct cause of  $Y$ ?

- (a)  $X$  and  $Y$
- (b)  $X$ ,  $Y$ , and  $Z$
- (c)  $W$  and  $Z$
- (d)  $X$ ,  $Y$ ,  $Z$ , and  $W$
- (e) None of the above

Deciding whether  $X$  is a direct cause of  $Y$  requires that you look at test pairs of causal assignments for  $X$  to see if there is a difference in the effect (in this case,  $Y$ ). This requires that you consider all of the variables in the causal system.

14. In which of the following causal graphs is  $Z$  an indirect, but not a direct, cause of  $Y$ ?

