Woodward 2
Total, Direct, and Contributing Causes

(pp. 45–61)

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Last time we saw:

Woodward's basic idea

The claim that X causes Y means that for at least some individuals, there is a possible manipulation of some value of X that they possess, which, given other appropriate conditions ... will change the value of Y or the probability distribution of Y for those individuals. (p. 40)

Today we'll refine that in two ways:

- The manipulation needs to be of the special kind that Woodward calls an *intervention*.
- We need to specify what other variables, if any, are held fixed when X is varied; different possibilities give different concepts of causation: Total, direct, and contributing cause.

Interventions

We may think of an intervention on X with respect to Y as an exogenous causal process that changes X in such a way and under conditions such that if any change occurs in Y, it occurs only in virtue of Y's relationship to X and not in any other way. (p. 47)

Example (pp. 46–47)

A=atmospheric pressure, B = barometer reading, S = whether there is a storm.
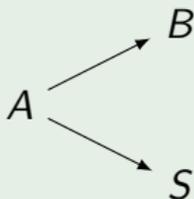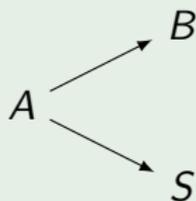

- Changing B by turning the adjustment screw in the barometer is an intervention on B with respect to S.
- Changing B by changing A is not an intervention on B with respect to S.
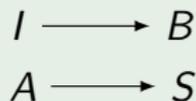
An intervention can be represented by a new variable *I* and its introduction changes the causal structure.

Example

In the barometer example, the original causal structure is:

$$A \nearrow B \searrow S$$

When the barometer reading is set by turning the adjustment screw in the barometer, the structure becomes:

$$I \longrightarrow B$$
$$A \longrightarrow S$$

Total cause

X is a total cause of *Y* iff there is a possible intervention on *X* that, for some value of other variables, will change *Y* or the probability distribution of *Y*. (paraphrased from pp. 50–51)
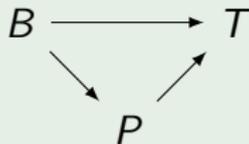
Example (p. 76)

S = whether there is a short circuit, *O* = whether oxygen is present, *F* = whether there is a fire.

$$S \searrow$$
$$\qquad\qquad F$$
$$O \nearrow$$
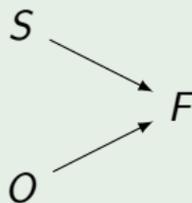
S is a total cause of *F*; so is *O*.

Thrombosis example (pp. 49–50)

Suppose birth control pills (B) directly cause an increased probability of thrombosis (T), but also lower the probability of pregnancy (P), which itself increases the probability of thrombosis.

$$B \longrightarrow T$$
$$\searrow \quad \nearrow$$
$$P$$

Suppose the influence of B on T along the two paths cancels out, so that taking birth control pills does not alter the probability of thrombosis; then B is not a total cause of T.

Direct cause

X is a direct cause of *Y* with respect to variable set **V** iff there is a possible intervention on *X* that will change *Y* or the probability distribution of *Y* when *all other variables in* **V** *are held fixed at some value by interventions*. (paraphrased from p. 55)

Drunk driving example (not Woodward's)

D = whether a driver is drunk, *C* = whether the driver has a collision, *N* = whether someone is injured.

$$D \longrightarrow C \longrightarrow N$$

- *D is not a direct cause of N with respect to* $\{D, C, N\}$: If we fix whether the driver has a collision, then changing whether the driver is drunk will not change the probability that someone is injured (let's suppose, for simplicity).
- *D is a total cause of N:* Changing whether the driver is drunk changes the probability of a collision and hence the probability that someone is injured.

$$B \longrightarrow T$$
$$\searrow \quad \nearrow$$
$$P$$
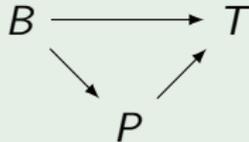
- We've seen that B is not a total cause of T, assuming the influences along the two paths cancel out.
- *B is a direct cause of T with respect to* $\{B, P, T\}$*:* If we intervene to ensure that a woman does not get pregnant, then an intervention that changes whether she takes birth control pills will change her probability of thrombosis.

So:

- A total cause need not be a direct cause.
- A direct cause need not be a total cause.

The notion ... of a contributing cause ... is intended to capture the intuitive idea of X influencing Y along some route even if, because of cancelation, X has no total effect on Y. (p. 50)

Definition

X is a contributing cause of Y with respect to variable set **V** iff (i) there is a path of direct causal relationships leading from X to Y, and (ii) there is some intervention on X that will change Y, or the probability distribution of Y, when all variables in **V** not on this path are fixed at some value. (p. 59)

Example (not Woodward's)

Suppose $Y_1 = X$, $Y_2 = -X$, and $Z = Y_1 + Y_2$.

$$X \nearrow \begin{matrix} Y_1 \\ \\ Y_2 \end{matrix} \searrow Z$$
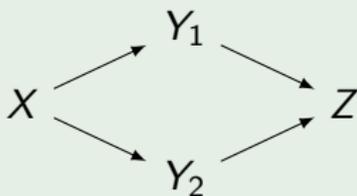
X is not a total or a direct cause of Z, but it is a contributing cause (with respect to these variables).

- The manipulability conception of causation says X causes Y if Y can be changed by changing or manipulating X.
- If X causes Y in any of the above three senses, then Y can be changed by changing X.
- The difference consists in what is held fixed when X is changed.

Type of cause	What is held fixed
total	nothing
direct	all variables other than X and Y
contributing	all variables not on one path from X to Y

Transitivity

For causation to be transitive means that if X causes Y, and Y causes Z, then X causes Z. None of the above three concepts of causation is transitive, as the following example shows.

McDermott's example (pp. 57–58)

A dog bites off my right forefinger. The next day I detonate a bomb by using my left forefinger. If I had not lost my right finger, I would have used it instead to detonate the bomb.

Let $B =$ whether a bite occurs, $L =$ whether I press the detonating button with my left finger, my right finger, or not at all (3 values), $E =$ whether the bomb explodes. In all three senses of causation (relative to these variables):

- B causes L
- L causes E
- B does not cause E

Questions

1. Explain what Woodward means by:
   (a) X is a total cause of Y.
   (b) X is a direct cause of Y with respect to variable set **V**.
   (c) X is a contributing cause of Y with respect to variable set **V**.

2. Suppose it is known that X, Y, and Z are related in one of the following two ways:

$$X \longrightarrow Y \longrightarrow Z$$
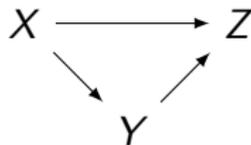
Describe how to determine experimentally which is correct.

3. Are the concepts of total cause, direct cause, or contributing cause transitive? Justify your answer.