Philosophy of Science

Lecture 8: Causation
Special Topic: Unifying Power

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The Birth of a Debate

Hume's scepticism

- Modern discussions of causation begin with the doubts Hume raises in the *Treatise*.

- There, he specifies the traditional view of causation in terms of a necessary connection between two events.

- But he then questions this view by arguing that we never experience any such thing as a necessary connection.

  "... even after experience has inform'd us of their constant conjunction, 'tis impossible for us to satisfy ourselves by our reason, why we shou'd extend that experience beyond those particular instances" (Section 1.3.6.11).

  NB: Recall that Hume is an empiricist!

Psychological habit

- As an alternative, Hume offers a psychological explanation of the necessary connection idea.

- Indeed, he suggests that experience of some uniformity (in the form of correlations) leads to a 'habit of the mind'.

  "These instances are in themselves totally distinct from each other, and have no union but in the mind, which observes them, and collects their ideas. Necessity, then, is the effect of this observation, and is nothing but an internal impression of the mind" (Section 1.3.14.20).

  NB: Setting aside his take on causation, Hume's 'mental habit' explanation has proved very influential in psychology.

A Menagerie of Accounts

Regularity accounts

- These views are direct descendants of Hume's comments on causation. Here's one version:

  X is the cause of *Y* if and only if (a) there is a regularity between *X* and *Y* and (b) *X* temporally precedes *Y*.

  NB: Condition *b* is there to safeguard causal asymmetry.

Regularity accounts: Problems

- Account:

  X is the cause of *Y* if and only if (a) there is a regularity between *X* and *Y* and (b) *X* temporally precedes *Y*.

- Problems:

  Irrelevance: Some conditions are irrelevant yet regular.
  Example: Regularity between putting hexed-salt in water and hexed-salt dissolving; that it is hexed is irrelevant.

  Spuriousness: Regularities because of a common cause.
  Example: Regularity between mercury drop in barometers and storms; both are caused by drop in atmosph. pressure.

Probabilistic accounts

- Initially, these had the form of mere probability-raising.

  C is a cause of *E* just in case $P(E|C) > P(E|\neg C)$.

- They have evolved into more complex accounts and have been deployed in scientific contexts to hunt for causes.

- Such accounts are able to model various cases that we intuitively deem as causal, including imperfect regularities.

  Example: Smoking is a major contributing factor of having lung cancer.

Probabilistic accounts: Problems

- Account:

  C is a cause of *E* just in case $P(E|C) > P(E|{\sim}C)$.

- Problems:

  Unwanted Symmetry: It cannot distinguish between cause and effect since $P(E|C) > P(E|\neg C)$ iff $P(C|E) > P(C|\neg E)$

  Spuriousness: It treats joint effects of a common cause as causing each other since in such cases $P(E_1|E_2) > P(E_1|\neg E_2)$.

Counterfactual accounts

- The most discussed account is that of Lewis (1973).

  E causally depends on *C* IFF (1) if *C* were to occur, *E* would occur and (2) if *C* would not occur, *E* would not occur.

- Such accounts are able to not just model actual cases of causation but also modal cases.

  Example: Life L causally depends on the presence of water W and other conditions C, e.g. range of temperatures.

  If W & C were to occur, L would occur. And if W & C would not occur, L would not occur.

Counterfactual accounts: Problems

- Account:

  E causally depends on *C* IFF (1) if *C* were to occur, *E* would occur and (2) if *C* would not occur, *E* would not occur.

- An early objection, put forth by Lewis himself, is the following:

  Marksmen *X* and *Y* take aim to kill a dictator *Z*. *Y* doesn't shoot since he sees *X* make the kill.

- Though we take *X*'s action to be the cause, it doesn't satisfy CD: had *X* not shot, *Z* would have been killed anyway!

Monism and pluralism

- As with many other key concepts in philosophy, competing accounts of causation have led to the rise of pluralism.

- Monists insist that there is a unified class of causal phenomena and thus a single concept of causation.

  Example: Salmon (1984); goes for a mark transmission view.

- Pluralists argue that there are a number of distinct classes of causal phenomena. Each requires its own concept.

  Example: Cartwright (2004).

A once segregated field

- In earlier days, advocates of each account were not always in contact with the ideas floated in other accounts.

- This was especially the case across philosophy sub-disciplines and in particular across major disciplines.

  "... the past few decades of work on causation and explanation have been characterized by a proliferation of self-contained schools with surprisingly little mutual influence or communication" (Woodward 2003: 3).

- Nowadays the situation is changing and there is much more cross-polination.

The Manipulability Account

Introduction

- One of the most influential accounts of causation in recent years is the manipulability (a.k.a. interventionist) account.
- The key idea is quite simple. Very roughly speaking:

  C causes *E* when *C* is a device or handle that allows for the systematic control (i.e. manipulation) of *E*.
- Collingwood (1940) is one of the earliest manipulationists.
- **Other proponents**: Menzies, Price, Pearl and Woodward.

Woodward's account

- Of the various accounts, Woodward's (2003) has helped propel the manipulationist point of view the most.

- His account is designed so as to do justice to (and hence be in part *descriptive* of):

  * the use of causal terms in **language**
  * causal inference and explanation **practices**
  * both the **everyday and the scientific context**
  * our **purposes** (manipulation and prediction)
  * the **objectivity** of causal/explanatory relationships

- Having said this, he also wants his account to have a normative dimension, i.e. to be corrective in some cases.

Two notions: Invariance and intervention

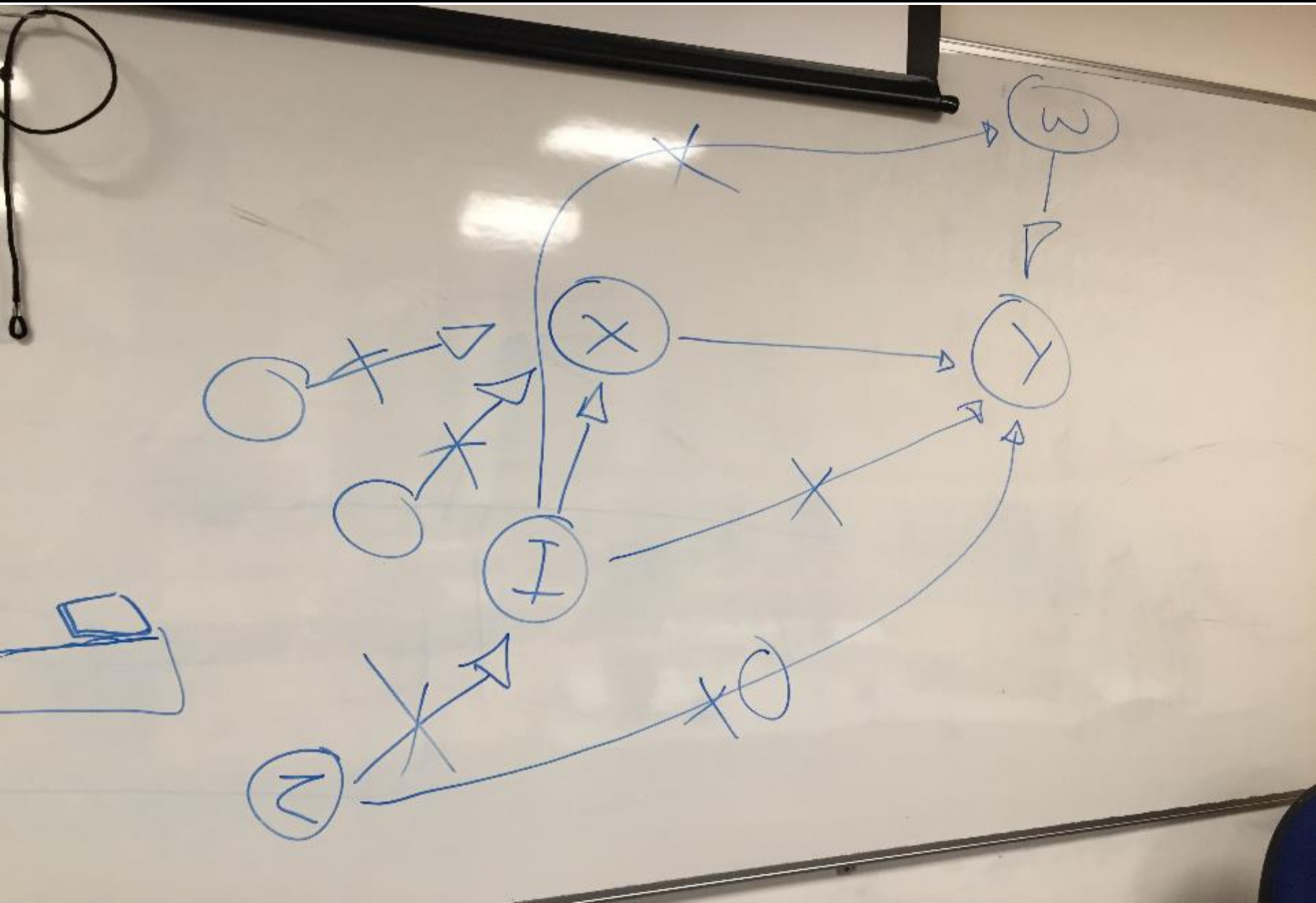
- To manipulate the world one needs information about **invariant** relations.

- Generally speaking, a property or relation is invariant when it remains unaffected under some class of changes.

- The **intervention** notion is construed by appeal to conditions that would need to hold in an ideal experimental situation.

  "an intervention on *X* with respect to *Y* changes the value of *X* in such a way that if any change occurs in *Y*, it occurs only as a result of the change in the value of *X* and not from some other source" (p. 14).

A diagrammatic representation



Invariance under intervention

- “A necessary and sufficient condition for a generalization to describe a causal relationship is that it be invariant under some appropriate set of interventions” (p. 15).

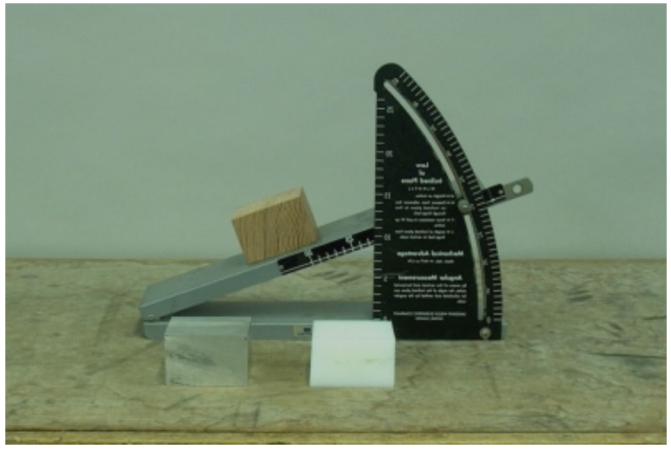
Examples

- Simply put, *X* is a cause of *Y* so long as:

  Intervening on *X* in some fixed circumstances invariably brings about (changes in) *Y*.

  Example 1: Intervening on the barometer does not change the storm, thus the former is not a cause of the latter.

  Example 2: Intervening on an inclined plane by changing its angle increases a sliding block's acceleration.



Modality

- Note that the said notions are understood *modally*:

  "[it] involves the identification of factors and relationships such that *if*... manipulation of these factors *were* possible, this would be a way of... altering the phenomenon in question" (p. 10) [original emphasis].

- Why is modality employed?

- Because things like past or large-scale events which cannot actually be manipulated by anyone can still count as causal.

A problem

- **Circularity**

  “Suppose that we agree that any plausible version of a manipulability theory must make use of the notion of an intervention and that this must be characterized in causal terms. Does this sort of ‘circularity’ make any such theory trivial and unilluminating?” (Woodward 2016)

Special Topic:
Unifying Power

In praise of unification

- Scientists, especially those in the natural sciences, praise the virtues of simpler and more unified theories.

  “Nature is after all simple, and is normally self-consistent throughout an immense variety of effects, by maintaining the same mode of operation” (Newton 1959, p. 418).

  “Our job in physics is to see things simply, to understand a great many complicated phenomena in a unified way, in terms of a few simple principles” (Weinberg 1979, ‘Nobel Prize Award Lecture’).

In praise of unification (2)

- E.O. Wilson (2005): “Biology is a science of three dimensions. The first is the study of each species across all levels of biological organization, molecule to cell to organism to population to ecosystem. The second... is the diversity of all species in the biosphere. The third... is the history of each species in turn, comprising both its genetic evolution and the environmental change that drove the evolution. Biology, by growing in all three dimensions, is progressing toward unification and will continue to do so” (p. 1).

Unification: Examples

- Some of the most famous examples of successor theories in history of the natural sciences exhibit a unificational trend.

  Newton's laws of motion and of gravitation
  Galileo's terrestrial physics, Kepler's celestial physics, movements of tides, the oblate shape of the Earth, etc.

  Maxwell's theory of electromagnetism
  Electric, magnetic and optical phenomena.

  Glashow-Salam-Weinberg electroweak theory
  Electromagnetism and the weak nuclear force.

Two sides of the same coin?

- **From unification to simplicity**:

  Suppose that to unify is to show how two seemingly distinct domains of phenomena can be accounted for together.

  That is, not by many different principles as they once were but by fewer, connected, ones. Then to unify is to simplify.

- **From simplicity to unification**:

  Suppose that to simplify is to show how the same phenomena can be accounted for by fewer principles.

  That is, those principles suffice to treat phenomena that were once treated separately. Then to simplify is to unify.

Unification as a marker

- Why are scientists, and why should they be, on the lookout for unified theories?

- Two main answers to such questions. Unification is EITHER

  (1) a truth marker, e.g. Kitcher (1989).

OR

  (2) a pragmatic/aesthetic marker, e.g. van Fraassen (1980).

  This dispute cannot be resolved unless we first have a good grasp of the notion of unification.

Three questions concerning unifying power

- Three crucial questions in the quest to fathom unification:

  (a) What does it **mean** for a theory to unify phenomena?

  (b) How, if at all possible, can we **measure** the degree of a theory's unifying power?

  (c) Does unification possess **truth-lending** qualities?

  NB: For b and c see Votsis (2015; 2017).

The End