Philosophy of Science: Explanation and Causality

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Tentative program: part II

- October 24: Explanation and Causality
- October 31: Philosophy of the Social Sciences
- November 7: Values in Science
- November 14: Models in Science
- November 21: Ethics and Political Philosophy of Science
- November 28: FINAL EXAM
Scientific reasoning

Scientific reasoning includes both deductive and inductive reasoning.

The problem of confirmation
- Theories or hypotheses
- Observation statements (and background assumptions)

The problem of explanation
- Theories or hypotheses (and initial conditions)
- An event or a phenomenon to be explained
Logical empiricism: a criticism

Puzzle:
Why would any one want to create epistemological problems by introducing theories and hypotheses that refer to unobservable entities, their properties, and relations? Why not just provide us with observation reports?

Answer:
Scientific inquiry aims to understand and explain, not merely to gather “facts”.

Basic concepts

- The explanandum is a description of the event or the state of affairs to be explained (with a relevant contrast class):
  
  Why did Adam eat the apple?
  Why did Adam eat the apple?
  Why did Adam eat the apple?

- The explanans is a description of that which does the explaining.

Van Fraassen, Bas. 1980. The Scientific Image. OUP.
Traditional approach

Explanations are arguments, either deductive or inductive.
DN model: deductive-nomological model
IS model: inductive-statistical model
-> The covering-law model: An event is explained by subsuming it under a law or a statistical generalization.


The covering-law model: an example

Why does a figure skater’s rate of rotation increase when she draws her arms close to her body?
The angular momentum of any body remains constant (law). The skater is not interacting with any external object in such a way as to alter her angular velocity.
The skater is rotating.
The skater reduces her moment of inertia by drawing her arms close to her body.
Therefore, the skater’s rate of rotation increases.
The deductive-nomological model

1. Deductive: The explanation must be a valid deductive argument where the conclusion is a description of the event to be explained.
2. Nomological: The explanans must contain at least one lawlike generalization that is well confirmed (in the example, the law of conservation of angular momentum).
3. The remaining premises stating the antecedent conditions must have empirical content and they must be true.

→ The challenge is to distinguish generalizations describing accidental regularities from genuine laws.

Counter-example #1

The flagpole and the shadow: Instead of deducing the length of the shadow from the height of the flagpole and the elevation of the sun, we can deduce the height of the flagpole from the length of the shadow and the elevation of the sun. The argument seems to be an adequate explanation of the height of the flagpole.

Conclusion: The D-N conditions are not sufficient to determine what constitutes an adequate explanation.
Lesson #1

We can explain effects by citing their causes but we cannot explain causes by citing their effects. Causes are thought to precede their effects in time.

Counter-example #2

The barometer and the storm: Given a drop in the reading of a barometer, we can predict that a storm will shortly occur. However, the reading on the barometer does not explain the storm. A drop in atmospheric pressure, which is registered by the barometer, explains both the storm and the barometric reading.

Conclusion: The D-N conditions are not sufficient to determine what constitutes an adequate explanation.
Lesson #2

Many times we find that two effects of a common cause co-vary with each other. But we do not explain one effect by means of the other.

Counter-example #3

- Why do you have a stain in your shirt?
- Because I spilled coffee on it while I was having my lunch.

Lesson #3: Many explanations are sufficiently good explanations even though they do not cite any general hypotheses. Therefore, the D-N model is not universally correct.
The inductive-statistical model: an example

Why did Jane recover from a neurosis?

Most people who have neurotic symptoms and who undergo psychotherapy experience relief from the symptoms.

Jane had neurotic symptoms and she underwent psychotherapy.

Therefore, it was *highly probable* that she experienced relief from her symptoms.

Criticism of the IS model

A high probability of the event to be explained is neither sufficient nor necessary for an explanation of the event:

1. *It is not sufficient* because it is possible that Jane’s symptoms would have disappeared without the therapy (with high probability). In other words, the therapy might not have been a causally relevant factor.

2. *It is not necessary* because the therapy can help Jane even if the probability that it helps other people is very low. In other words, the therapy might have been a causally relevant factor even if the probability of the symptoms disappearing is low.
Lesson #4

The explanans gives an explanation of the explanandum insofar as it provides an account of at least some of the causal factors that have generated the event or the state of affairs to be explained.

In order to understand explanations, we need to understand causality.


A Humean conception of causality

- The description of the cause and the effect must be conceptually independent of each other.
- The cause must precede the effect in time.
- The cause and the effect must be covariant.

Corollary: We cannot study causal relations by means of conceptual analysis. Knowledge about causal relations (if feasible) is necessarily based on empirical evidence.
Criticism

- Covariance (together with the other two conditions) is not a sufficient condition for causality because covariance may take place between two effects of a common cause (e.g., the barometer and the storm).
- Covariance is not a necessary condition for causality because covariance might disappear because of other causal factors.

An alternative to Hume’s conception of causality?

An event of the type A is a cause of an event of the type B if and only if it is the case that

if an event $A_1$ had not taken place, then an event $B_1$ would not have taken place either (a counter-factual conditional).

Can we have observations of any causal relations?
A scientific experiment

We create at least two settings similar in those respects that are believed to be causally relevant. In the first setting, we make an intervention. If we observe a change in the first setting and not in the second setting, then we conclude that the intervention was the cause of the observed change.

A scientific experiment

For scientific reasoning, the most important aspect is the second setting; it allows us to make the counter-factual claim that “If we do not intervene, then there will be no changes.”
Ceteris paribus

Many general causal hypotheses are qualified by a ceteris paribus condition ("other things being equal").

Also, scientific reasoning in experiments requires that the two settings are similar in all other respects that are believed to be causally relevant (except the one tested).

Statistical relevance

In order to find out whether psychotherapy is a causally relevant factor in reducing neurotic symptoms, we need to find out whether the probability of the symptoms disappearing is higher among those who undergo a therapy than among those that do not undergo a therapy. We also need to consider the possibility that there may be other factors causing the symptoms to disappear than the therapy.
Singular causal explanations

A causal explanation does not need to appeal to a general causal hypotheses (about events of the type A causing events of the type B). A causal explanation can appeal to a singular causal relation.

Example:
- Why did the war start?
- Because the president failed to negotiate about the conflict.

A pragmatic account of causal explanation

For any event or a state of affair there are numerous antecedent conditions which are causally relevant in generating the event or the state of affairs to be explained. But not all causally relevant factors are explanatory factors. The pragmatic factors in explanation determine why some causally relevant factors are considered as explanatory factors.
Example

- Why did the house burn down?
- Because the coffee machine was not turned off.

What other causal factors are relevant in the case of a fire? Why does one focus on the coffee machine in the explanation?

Contextualism and explanation

If we accept a pragmatic account of causal explanation, then the standards of good explanation are partially dependent on the context.

The context determines what kinds of causal factors are seen as interesting.

It determines also how fine-grained accounts of causal processes are seen as necessary for understanding.
Contested issues

- Do good explanations require a unification of the phenomena to be explained?
- Do good explanations require an account of mechanisms?
- Is the counterfactual conception of causation a universally correct one?