Week 7

Explanation

Bridgman, Hempel

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Outline

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1 Bridgman on explanation

Explanation as reduction

- In this wonderfully written, but largely ignored, text Bridgman anticipates some much later developments in the theory of explanation, as well as (I think) some ideas of Kuhn's (to be covered later in the course).
- Bridgman begins by baldly stating his thesis: to explain the phenomenon is to reduce it to the already familiar phenomena.
- The meaning of reduction: to identify *correlations*, which I take to be causal connections.
- Logically, there is no limit to explanation, but operationally there is.

Question
What is the operational limit of explanation?

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Subjectivity of explanation

Immediate implication of Bridgman's view: explanation can work for some, but not for others:

> The savage is satisfied by explaining the thunderstorm as the capricious act of an angry god. The physicist demands more, and requires that the familiar elements to which we reduce a situation be such that we can intuitively predict their behavior. Thus even if the physicist believed in the existence of the angry god, he would not be satisfied with this explanation of the thunderstorm because he is not so well acquainted with angry gods as to be able to predict when anger is followed by a storm. He would have to know why the god had become angry, and why making a thunderstorm eased his ire.

Remark
Compare this view with van Fraassen's to be covered later.

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Explanatory crisis

- Explanations can be terminated in a number of ways.
- We can reduce the complexity of the given phenomena to other phenomena already understood.
- Or we can reduce the given phenomena to something utterly obscure.
- This last situation signifies a crisis (examples: quantum mechanics, relativity theory).
- To deal with the crisis, we are advised to accumulate experimental data in order to make the previously unfamiliar phenomena more familiar.
- But: it is very unclear how exactly the enlargement of experience can accomplish this.
- Are we supposed to simply get used to the new phenomena?
- Elements of scientific development ignored by Bridgman: conceptual progress, philosophical critique, the role of mathematical formalism.

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Mechanism

- The third way to terminate explanations is by showing mechanical correlations between the phenomena.
- Example: the theory of aether invoked to explain electricity and electromagnetism.
- While acknowledging the futility of this approach in general, Bridgman seems to welcome it in the situations where the mechanism shows correlations between already familiar phenomena.
- (I am not sure I understand, however, how the third way of termination will be different from the first one.)
- In any event, I think the question to be asked is: given the widespread use of mechanistic explanations, what is the source of their appeal?
- And the answer, I think, is that mechanisms display clean, visualisable causal relations.
- But we have already seen the problems raised about causation.
- Therefore, not surprisingly, the positivist approach was to bypass causal explanations altogether—as we are going to see immediately.

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2 Deductive-nomological explanation

The D-N model

Hempel proposes the following model of explanation:

Laws: $L_1, \ldots, L_n$
Conditions: $C_1, \ldots, C_m$
Explananda: $E_1, \ldots, E_k$

- Explanations are arguments.
- The laws and the initial conditions, both understood as statements, logically entail the explananda.

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How the D-N model works

Example 1. Suppose we have a container of gas (say, a syringe). We increase the volume of the container by one-third. The observed phenomenon is the decrease in the gas pressure by 25%. To explain the phenomenon we use Boyle's Law: $PV = T$, assuming the temperature remains constant:

Laws: $PV = T$.
Conditions: The volume of the container increases by one-third, the temperature is constant.
Explananda: The decrease in the gas pressure by 25%.

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3 Problems

Two kinds of explanation

- Hempel notes two features of explanation practices.
- One is that we often wish to explain laws themselves. We may ask why a particular law holds.
- What we usually do in such cases is subsume those laws under even more general laws. From these more general laws we can infer the more specific laws that are our concern.
- However, in page 48 Hempel also advances the idea that the less general laws are only approximations of the more general laws.
- If so, it is left unclear how a D-N explanation, while remaining a logical argument, is supposed to work in the cases of explaining laws with laws.

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The same old story

Example 2. Consider Galilean and Lorentz transformations that are at the root of Newtonian and relativistic mechanics respectively:

$$\begin{aligned} x' &= -\frac{x-ut}{\sqrt{1-\frac{u^2}{c^2}}} \\ y' &= y \\ z' &= z \\ t' &= \frac{t-\frac{ux}{c^2}}{\sqrt{1-\frac{u^2}{c^2}}} \end{aligned}$$

$$\begin{aligned} x' &= x-ut \\ y' &= y \\ z' &= z \\ t' &= t, \end{aligned}$$

When the velocity u is much smaller than c, we get approximately same results in the calculations. But you cannot logically derive Galileo from Lorentz.

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Difficulties I

- The D-N model was subject to intense scrutiny and unforgiving criticism.
- Let us mention two difficulties that were brought up in the ensuing debate.
- One is the problem of *pre-emption*.

Example 3. Suppose that Jones drinks a poison. And suppose there is a law saying that anyone who drinks that poison will die within 24 hours. However, shortly afterwards Jones is hit by a bus. According to D-N, his death is explained by drinking the poison. This seems wrong.

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Difficulties II

- Another difficulty is *symmetry*.
- Suppose we increase the volume of the gas in a syringe.
- Then, given that the temperature is constant, Boyle's law should explain why the pressure subsequently drops: $PV = T$.
- But equally, that later drop in pressure also explains why the volume increases.
- This is clearly wrong.

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4 Probabilistic explanation

The P-S model

- The D-N model involved deterministic laws.
- But not all laws are deterministic: some of them are probabilistic.
- In such cases Hempel proposes the following model of explanation:

  Probabilistic law: $0 \ll P(O \mid F) < 1$

  Factors: F_i

  Explanandum: O_i

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The contrast between D-N and P-S

- Probabilistic explanations, in contrast to D-N explanations, are not deductive arguments.
- Assuming the law and the factors (i.e. a conjunction of factors), we must be able to conclude that the explanandum is 'very likely'.
- In other words: the law and the factors give inductive support to the explanandum.

Question
Why cannot the P-S explanation be a deductive argument?

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How the P-S model works

Bronchitis
Suppose you fall sick with bronchitis. You are prescribed antibiotics. Your subsequent recovery was not necessitated by taking antibiotics: it is not as if you necessarily had to recover, for the disease might have progressed further. Nevertheless you were, we say, likely to recover. We have:

Probabilistic laws: $0 \ll P(\text{Recovery} \mid \text{Taking antibiotics and having bronchitis}) < 1$.
Factors: You are sick with bronchitis and take antibiotics.
Explanandum: You recover.

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Difficulties I

- A key weakness of Hempel's account is the demand for the dramatic increase of the inductive support for the explanandum produced by the factor F.
- Suppose you fall sick with a bronchitis and later, despite being treated with antibiotics, develop pneumonia.
- Though $P(\text{Pneumonia} \mid \text{Bronchitis treated with antibiotics})$ is not high, it still should be able to explain your pneumonia.
- Thus fulfilling Hempel's requirements will not be a *necessary* condition of a successful probabilistic explanation.

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Difficulties II

- Hempel's requirement might not even be *sufficient*.
- Suppose you fall sick with a common cold and recover within two weeks while reading poetry every day.
- Well, $P(\text{Cold} \mid \text{Reading poetry for two weeks})$ is quite high, since common cold usually disappears within two weeks.
- But surely reading poetry does not explain it.
- We would like to say that reading poetry is *irrelevant* for the explanation.
- But Hempel's account gives us no tools for distinguishing between relevant and irrelevant factors.

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