Scientific Reasoning
Lecture-Seminar 3
'Explanation and Confirmation'

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Explanation: A first look

- Some intuitions about good scientific explanations:

  - Provide answers to *why, how, etc.* questions.
  - Confer understanding.
  - Put forth claims about (and hence predict) the world.

- **Desideratum**:

  An account of explanation that subsumes all cases we intuitively deem good and excludes all cases we deem bad?

The Covering Law Model

The covering law model

- **Origin:** Logical Empiricists

- CLM takes explanations to be:

  - arguments
  - premises contain particular and general claims (laws)
  - symmetrical with predictions
  - by and large, rational reconstructions

- The model encompasses two complementary accounts:

  (1) The Deductive-Nomological (DN) account
  (2) The Inductive-Statistical (IS) account

The Deductive-Nomological Account

The deductive-nomological account

- On this account, good explanations are arguments possessing the following four features:

  (a) deductive validity
  (b) true premises
  (c) empirical content
  (d) at least one deterministic law of nature

  NB: The premises are assumed to be non-redundant.

- **Prominent proponents**: Hempel, Oppenheim and Nagel.

The deductive-nomological account: The schema

$$\begin{array}{l} 1.\ C_1, C_2, \ldots, C_n \\ 2.\ L_1, L_2, \ldots, L_m \\ \hline \therefore E_1 \end{array} \quad \begin{array}{l} \left.\vphantom{\begin{array}{l}C\\L\end{array}}\right\} \textit{Explanans / Explicans} \\ \textit{Explananandum / Explicandum} \end{array}$$

C_1 - C_n stand for descriptions of particular facts
L_1 - L_m for descriptions of laws and
E_1 for a description of that which is explained

Example: Free falling objects

- Suppose we want to find out why two objects dropped from a given height reach the bottom at the same time.

1. All freely falling bodies fall with constant acceleration.
2. *X* and *Y* are free falling bodies.
3. *X* and *Y* are released from height *x* simultaneously.

$\therefore$ *X* and *Y* will reach the ground simultaneously.

red: law
green: initial conditions

NB: The 'free falling' restriction means that nothing interferes with their fall.

[redacted]

Explaining laws and theories

- This model also provides explanations of generalisations.

- Hempel: "...the question, 'Why do Galileo's and Kepler's laws hold?' is answered by showing that these laws are but special consequences of the Newtonian laws of motion and of gravitation; and these, in turn, may be explained by subsumption under the more comprehensive general theory of relativity"([1962] 1998, pp. 686-7).

Einstein's Theory of Relativity

Newton's laws

Galileo's laws + Kepler's laws

Explaining laws and theories (2)

- Such explanations lead to an increase in "the breadth and the depth of our scientific understanding" (p. 687).

- **Breadth**: A broader range of phenomena is covered.

  <u>Example</u>: Newtonian laws explain (over and above those of Galileo and Kepler) motions of comets, satellites and tides.

- **Depth**: The phenomena are more accurately described.

  <u>Example</u>: Newtonian laws explain (contra Kepler's first law) that orbits are not perfect ellipses.

On the DN account, good explanations are arguments with the following features:

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DN explanations can be given for

particular phenomena and mathematical laws

mathematical laws

particular phenomena and laws of nature

laws of nature and laws of logic

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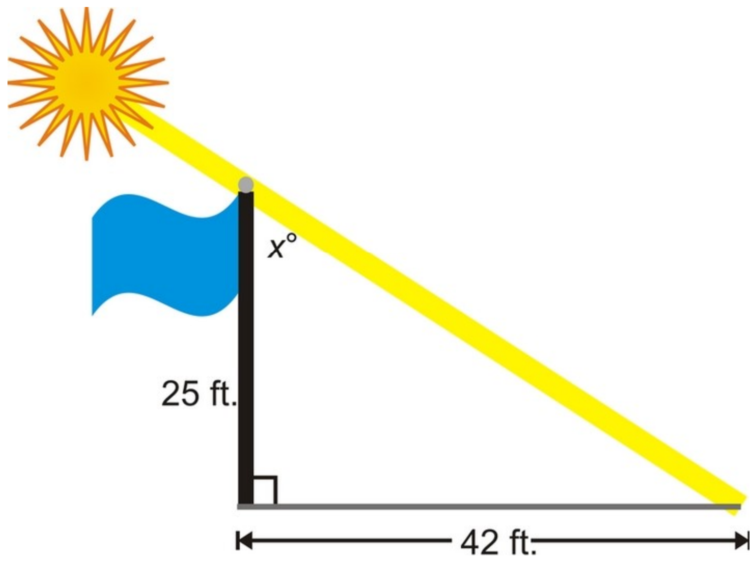
Some Problems

Against the sufficiency of DN

- Not all DN explanations are good deterministic explanations.

- **Flagpole example** (Bromberger 1966).

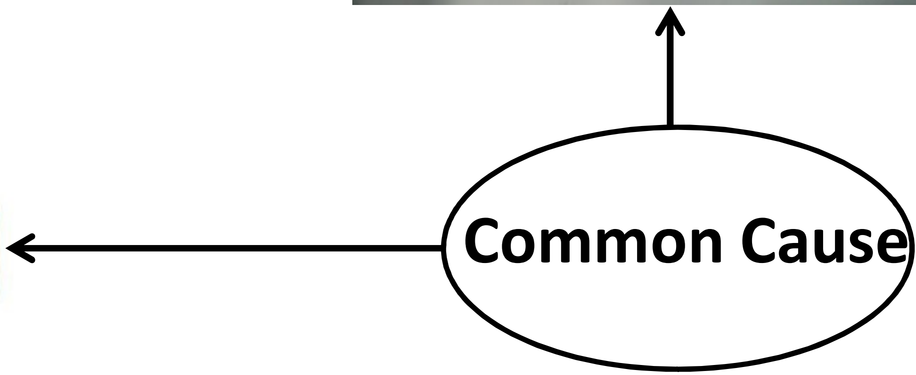


- We can derive the height of the flagpole from the given premises but it doesn't seem like a good explanation.

  NB: Asymmetry between explanation and prediction!

Against the sufficiency of DN (2)

- **Barometer example**:
  We might be able to derive the coming of the storm from the drop in barometric pressure but we cannot explain it thus.



NB: Asymmetry between explanation and prediction!

Against the necessity of DN

- Not all good deterministic explanations are DN ones.

- **Ink-bottle example** (Scriven 1959/1962)

"If you reach for a cigarette and in doing so knock over an ink bottle which then spills onto the floor, you are in an excellent position explain to your wife how that stain appeared on the carpet, i.e., why the carpet is stained... This is the explanation of the state of affairs and there is no nonsense about it being in doubt because you cannot quote the laws that are involved..." (p. 198).

A general problem for CLM

- Historical explanations are often concerned with one-off, i.e. unique, events.

  Examples: The trial of Anne Boleyn in 1536, the battle of Waterloo in 1815, the fall of the Berlin wall in 1989.

- Such explanations thus seem to rarely, if ever, appeal to laws, deterministic or probabilistic.

- More generally, explanations in social science and the humanities do not seem to appeal to laws.

  NB: Not least because they have few, if any, laws.

Replies

Tackling the counterexamples

- Contrast the following two *explananda*:

  Q1: Why is the flagpole so high?
  A: It's so high <u>because</u> it was designed by *X* to be that way.

  Q2: How high is the flagpole?
  A: It's *y*-meters high <u>as shown by</u> the length of its shadow.

- DN advocates could claim that, given the said premises, their account only provides an answer to Q2.

Elliptical explanations

- Drawing on an analogy w/mathematics, Hempel asserts:

  "When a mathematician proves a theorem, he will often omit mention of certain propositions which he presupposes... he then simply assumes that his readers or listeners will be able to supply the missing items... Similarly, explanations put forward in everyday discourse and also in scientific contexts are often *elliptically formulated*" (p. 691) [original emphasis].

  NB: Why opt for elliptical formulations? Expedience!

- Returning to the ink-bottle case, DN advocates hold that the non-elliptical version would have to cite laws of nature.

Explanation in the social sciences and humanities

- One might argue that the social sciences & humanities are less developed because their domains are more complex.
- They thus cannot be expected at present to have well-confirmed laws and thus to give *complete* explanations.
- In short, it is not the DN that's at fault but rather the kinds of explanations currently on offer in these disciplines.
- But perhaps it needn't even come to that. Instead, one can give 'laws' a softer, law-like generalisations reading.

Confirmation

Confirmation theory

- Confirmation theory as a subject can be characterised thus:

  The study of the conditions under which evidence (ought to) support(s) a hypothesis.

- There are two ways to express such evidence-hypothesis relations:

  qualitatively vs. quantitatively

- When we do express such relations quantitatively, the characterisation of confirmation changes thus:

  The study of the conditions under which evidence (ought to) support(s) a hypothesis and of the level of that support.

Hypothetico-Deductivism

Popper’s hypothetico-deductivism

- Recall that in Popper’s view, scientists never (or at least ought not to) reason inductively. Rather, they reason:

  * *Conjecturally* (in the context of discovery)

  * *Deductively* (in the context of justification)

- This view is also hypothetico-deductive. In fact, Popper is often cited as an exemplary advocate of this approach.

- Keep in mind, however, that Popper *denies* confirmation takes place. Instead, he insists on corroboration.

Hypothetico-deductivism as a confirmation theory

- General schema:

  1. Central hypothesis
  2. Auxiliary assumptions

  ∴ Observational consequence

- According to this view:

  If these consequences turn out true, then we say that the hypothesis + auxiliaries are *confirmed*.

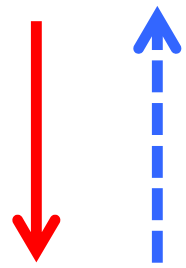
  If these consequences turn out false, we say that they are *disconfirmed (and even refuted)*.

- **Proponents**: Huyghens, Newton and the Logical Positivists.

The upward flow of support

- Though it is deductive in extracting consequences, it is inductive in the support these offer to the premises.

1. Central hypothesis
2. Auxiliary assumptions
∴ Observational consequence



red arrow: extracting consequences
blue arrow: supporting the premises

- Thus, there is an upward flow of support from true consequences to the hypothesis + auxiliaries.

Hypothetico-deductivism: A quotation

- "There will be seen in it [i.e. in his book *Treatise of Light*] demonstrations of those kinds which do not produce as great a certitude as those of [Euclidean] Geometry, and which even differ much therefrom, since whereas the Geometers prove their Propositions by fixed and incontestable Principles, here the Principles are **verified by the conclusions** to be **drawn from them**... when things which have been **demonstrated by the Principles** that... correspond perfectly to the phenomena which experiment has brought under observation... this ought to be a very **strong confirmation**" (Huyghens 1962[1690]: vi–vii).

  red: deduction
  green: induction

Hypothetico-deductivism: example

- Adapted from Salmon et al. (1999:47), this example uses the wave theory's main rival, namely the corpuscular theory:

  1. Light consists of corpuscles that travel in straight lines unless there is a change in medium density.
  2. Source A ejects light onto a circular object B.
  3. The medium density between A and B remains the same.

  ...

  ∴ The object casts a uniform circular shadow.

  NB: Although the conclusion is validly derived from the premises, it is actually false.

Paradoxes and other Objections

The raven paradox

- Consider the following hypothesis:
  H_1: All ravens are black

  Now consider the logically equivalent hypothesis:
  $H_1´$: All non-black things are non-ravens

- We can derive that a specific non-black thing will be a non-raven from is from $H_1´$. If that's true, $H_1´$ is confirmed by it.

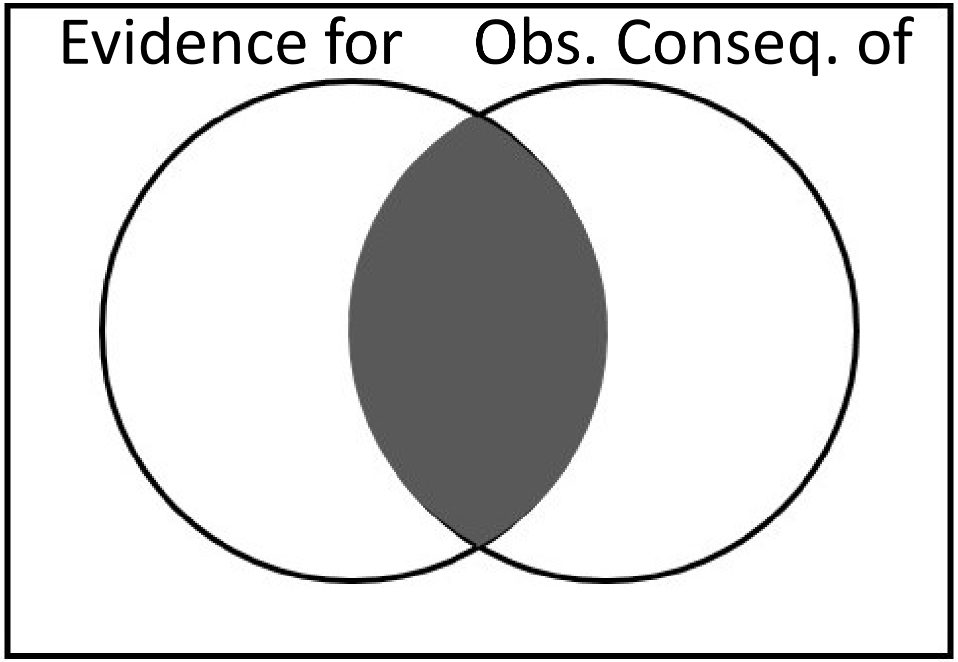
- Since H_1 is logically equivalent to $H_1´$ we can also derive that claim from H_1.

- But it seems absurd to claim that a non-black non-raven thing, e.g. *a white sock*, confirms H_1.

Divergence: Evidence and empirical consequence

- Laudan and Leplin (1991) argue against H-D model (as well as the positive instance model of confirmation).

evidence for $H \neq$ observational consequences of H



Evidence for *H*, but not consequence of *H*

- (1) Some evidence for *H* does not follow from *H*.

  Example: Prior observations of *F*s that are *G*s are evidence *e* for *H*: 'The next *F* will be a *G*' but they do not follow from it.

  ~~1. The next *F* will be a *G*~~

  ~~∴ Some prior F was a G~~

  H **does not entail** *e*

  1. This thing is an *F* and a *G*

  ...

  n. This other thing is an *F* and a *G*

  The next *F* will be a *G*

  Yet *H* is **inductively supported by each** *e*.

Consequence of *H*, but not evidence for *H*

- (2) Some consequences of *H* do not provide support for *H*.

  Example: Hypothesis 'Reading scripture regularly induces puberty in young males' not supported by its consequences.

  Reading scripture regularly induces puberty in young males.

  ∴ This young male who regularly read scripture hit puberty.

- Although the conclusion *e* validly follows from the premise *H*, it does not support *H*. That's because:

  Young males who didn't read scripture regularly (or at all) also hit puberty. Hence *e* is evidentially irrelevant to *H*.

The End