Philosophy of Science

Lecture 3: Hypothetico-Deductivism
Special Topic: Ad Hoc-ness

Dr. Ioannis Votsis
ioannis.votsis@nchlondon.ac.uk
www.votsis.org

Introduction

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

Hypothetico-deductivism: The origins

- Recall that in Popper's view, scientists almost never reason inductively. Rather, they reason:

  * *Conjecturally* (in the context of discovery)

  * *Deductively* (in the context of justification)

- This view leads naturally to the hypothetico-deductive (H-D) account of confirmation, though it predates Popper.

  Proponents: Logical Positivists, Popper, Gemes and Horwich.

Hypothetico-deductivism: The simple version

- 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)*.

  NB: More sophisticated variants exist, e.g. Gemes (2005).

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.

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: (potentially) supporting the premises

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

The Positive Instance Model

Positive instances

- Carl Hempel (1945), following Jean Nicod, suggested that:

  * hypotheses are *confirmed* by positive instances
  * hypotheses are *disconfirmed* by negative instances

  Suppose our hypothesis is 'All *F*s are *G*s'.

  positive instance: *Fa* & *Ga*.
  negative instance: *Fa* & ¬*Ga*.

- This approach is known as the 'positive instance' or 'instantial' model of confirmation.

  Proponents: Hempel, Glymour and Nicod.

The logic of positive instances

- Note that from $(\forall x)\,(Fx \longrightarrow Gx)$ we can derive all sorts of specific instances of the conditional: $Fa \longrightarrow Ga$, $Fb \longrightarrow Gb$, ...

- So-called 'positive instances', by contrast, often come in conjunctive form: $Fa \;\&\; Ga$.

- That's not really a problem as from $Fa \;\&\; Ga$ we can derive $Fa \longrightarrow Ga$ via conditional proof.

$$\begin{tikzcd}
(x)\,(Fx \longrightarrow Gx) \arrow[d, "\text{entails}"'] & Fa \;\&\; Ga \arrow[l, "\text{confirms}"] \arrow[dl] \arrow[d, "\text{entails}"'] \\
Fa \longrightarrow Ga & Fa \longrightarrow Ga
\end{tikzcd}$$

Hempel's adequacy criteria

- Hempel sets out some criteria that any qualitative account ought to satisfy. They include (but are not limited to):

  Equivalence condition (EQC):
  If *e* confirms *H*, then *e* confirms any *H'*, where $H \equiv H'$.

  Entailment condition (ENC):
  If $e \vDash H$, then *e* confirms *H*.

  Special consequence condition (SCC):
  If *e* confirms *H* and $H \vDash H'$ then *e* confirms *H'*.

- He rejects the **converse consequence condition (CCC)**:
  If *e* confirms *H* and $H' \vDash H$ then *e* confirms *H'*.

H-D vs. positive instance confirmation

- The two are closely related. After all, any* consequence of a hypothesis counts as a confirmation in both models.

- However, in some cases the two models diverge.

  Suppose:
  e: *a* is a black swan.
  H: There is at least one black swan.

  Hempel's model: *e* confirms *H* via ENC.

  H-D model: *e* is neutral with respect to *H* because $H \nvDash e$ and $H \nvDash \neg e$.

Which of the following conditions is NOT endorsed by Hempel?

Entailment

Converse consequence

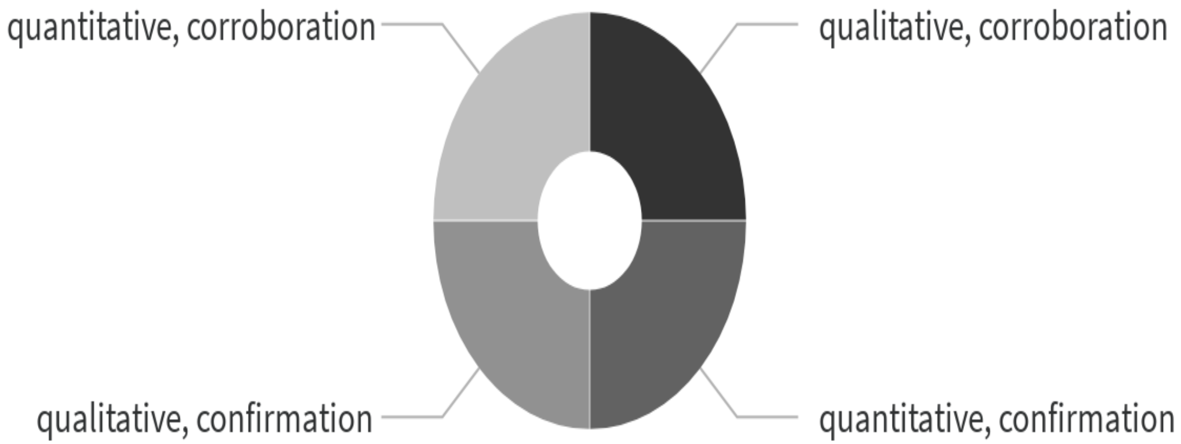
Equivalence

Special consequence

Start the presentation to see live content. Still no live content? Install the app or get help at **PollEv.com/app**

The Positive Instance Model is a __________ theory of __________.

qualitative, corroboration **A**
quantitative, confirmation **B**
qualitative, confirmation **C**
quantitative, corroboration **D**



Crucial Experiments

What is a crucial experiment?

- Robert Hooke coins the term ‘experimentum crucis’ in *Micrographia* (1665).

  NB: He wrongly attributes it to Francis Bacon who in fact used the term ‘instantia crucis’.

- Although Hooke doesn’t define the term, it’s pretty clear what he and others mean by it.

  Such experiments are meant to provide a *definitive opportunity to refute* a hypothesis.

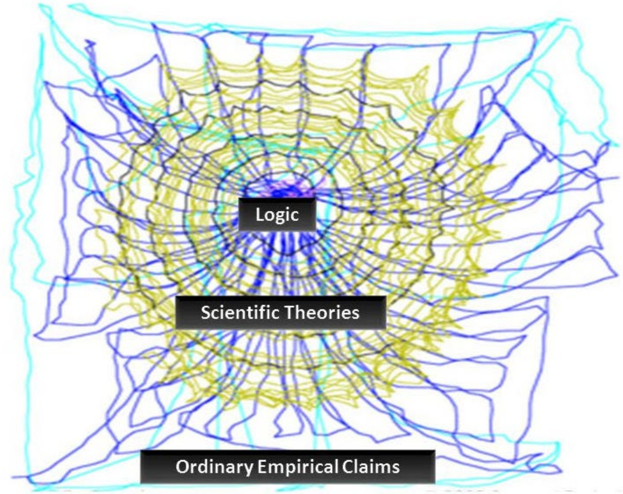
Duhem, Quine and their namesake thesis

- Pierre Duhem insists that such experiments are impossible.

- **Duhem's thesis** (1906): Hypotheses cannot be tested in isolation as they don't have consequences on their own.

- **Web-of-belief metaphor** (Quine 1951):

  All our beliefs are nestled in an interconnected web of support.



- Despite some differences between the two, the first view is now widely known as the **Duhem-Quine thesis**.

Duhem's thesis: The rationale

- Suppose a given consequence is indeed false. What should we do? Start from scratch or try to revise?

- Moreover, can we infer which premise, i.e. central hypothesis or one of the auxiliaries, is to blame?

  Duhem's answer: **No**!

- Recall that a false (F) conclusion can be validly derived from *one or more* false premises.

- Otherwise put, the content of a conclusion – in this case F – is included in the premises but we don't know where.

The possibilities

- When an observational consequence is false we can only infer that *at least* part of the system is at fault.

1. Central hypothesis
2. Auxiliary assumption *1*
…
n. Auxiliary assumption *n-1*
$\therefore$ Observational consequence *1* (False)

The possibilities

- When an observational consequence is false we can only infer that *at least* part of the system is at fault.

1. Central hypothesis
2. Auxiliary assumption *1*
…
n. Auxiliary assumption *n-1*
$\therefore$ Observational consequence *1* (False)

The possibilities

- When an observational consequence is false we can only infer that *at least* part of the system is at fault.

1. Central hypothesis
2. Auxiliary assumption *1*
…
n. Auxiliary assumption *n-1*
∴ Observational consequence *1* (False)

The possibilities

- When an observational consequence is false we can only infer that *at least* part of the system is at fault.

1. Central hypothesis

2. Auxiliary assumption *1*

…

n. Auxiliary assumption *n-1*

∴ Observational consequence *1* (False)

The possibilities

- When an observational consequence is false we can only infer that *at least* part of the system is at fault.

1. Central hypothesis
2. Auxiliary assumption *1*
…
n. Auxiliary assumption *n-1*
∴ Observational consequence *1* (False)

The possibilities

- When an observational consequence is false we can only infer that *at least* part of the system is at fault.

1. Central hypothesis
2. Auxiliary assumption *1*
…
n. Auxiliary assumption *n-1*
∴ Observational consequence *1* (False)

The possibilities

- When an observational consequence is false we can only infer that *at least* part of the system is at fault.

1. Central hypothesis
2. Auxiliary assumption *1*
…
n. Auxiliary assumption *n-1*
___
∴ Observational consequence *1* (False)

Replacement, not addition

- If a consequence *C* of a system (of theories or beliefs) is false, it is impossible to rectify it by *merely adding* premises.

- That's because classical logic is *monotonic*: One can never remove content or consequences by adding premises.

$$\frac{\Gamma \vdash C}{\therefore\ \Gamma, A \vdash C}$$

- So, to remove an offending consequence, one or more parts of the system must be *replaced* or *removed*!

NB: Replacement is equivalent to removal + addition.

Does Duhem's point differ from Quine's? If so, in what respects?

Start the presentation to see live content. Still no live content? Install the app or get help at **PollEv.com/app**

Paradoxes and other Objections

The raven paradox: HD and PIM under attack

- Consider the following hypothesis:
  H_1: All ravens are black $(\forall x)\,(Rx \rightarrow Bx)$

  Now consider the logically equivalent hypothesis:
  $H_1{'}$: All non-black things are non-ravens $(\forall x)\,(\neg Bx \rightarrow \neg Rx)$

  The latter is confirmed by positive instances: $\neg Ba \ \& \ \neg Ra$.

- But note that, via EQC, evidence that confirms a hypothesis confirms any logically equivalent hypothesis.

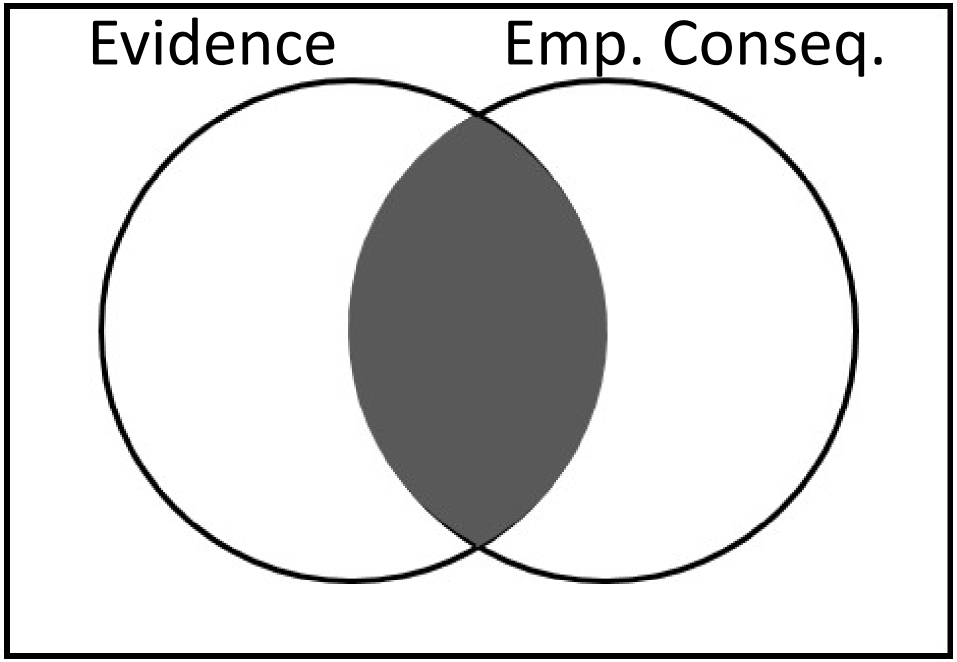
  NB: It's also the case that $\neg Ba$ and $(\forall x)\,(Rx \rightarrow Bx)$ entail $\neg Ra$.

- Contra intuitions, *a white sock* confirms H_1!

Divergence: Evidence and empirical consequence

- Laudan & Leplin (1991) argue against the co-extensionality of *empirical consequence* and *evidentially relevant sentences.*

evidence for $H \neq$ empirical consequences of H



Two reasons against co-extensionality

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

Example: Prior observations of *A*s that are *B*s are evidence for ‘The next *A* will be a *B*’ but they do not follow from it.

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

Example: The hypothesis ‘Reading scripture induces puberty in young males’ is not supported by its consequences.

The consequences are sentences expressing that males have reached puberty after having read scripture.

Special Topic:
Ad hoc Hypotheses

Everyday discourse

- Given the notion’s prevalence in everyday discourse, a dictionary entry makes for an apt starting point.
- According to the Oxford English Dictionary, ‘ad hoc’ means “formed, arranged, or done for a particular purpose only”.
- This ordinary conception of ad hoc-ness is reflected in compound expressions like ‘ad hoc committee’.
- But what does it mean for a hypothesis to be ad hoc?
- Several conceptions of ad hoc-ness have arisen through the years. In what follows, we consider Popper’s conception.

Popper's 'excess testable consequences'

- This conception unpacks the specificity of an ad hoc hypothesis in terms of its lack of excess testable content.

  "*Ad hoc* explanations are explanations which are not independently testable... In order that the *explicans should not be ad hoc, it must be rich in content*: *it must* have a variety of testable consequences, and among them, especially, testable consequences which are different from the *explicandum*. *It is these* different testable consequences which I have in mind when I speak of *independent tests*, *or of independent evidence*" (1972, pp. 15-16, 193) [orig. emph.].

- Its connection to the ordinary conception of ad hoc-ness should be obvious.

Popper's account: Example

- Suppose H_1 helps explain (w/the Newtonian paradigm) E_1.

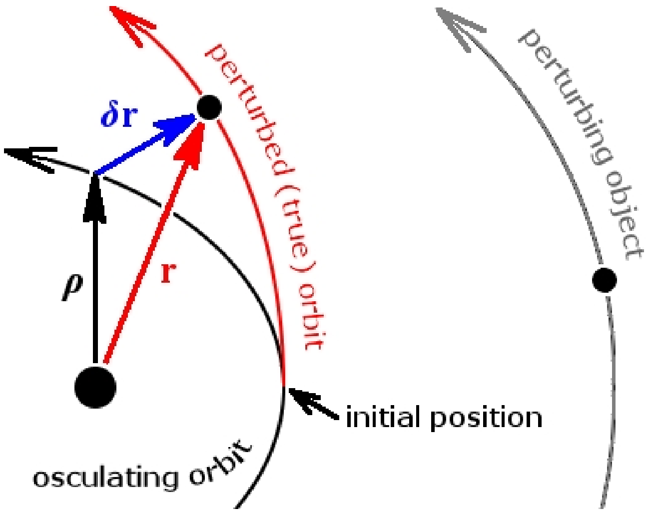
  H_1: 'Neptune has certain orbital and mass characteristics'

  E_1: 'The orbit of Uranus is perturbed'.

- **But** H_1 has excess testable content over and above E_1.

- It predicts perturbations in the orbits of:

  * all planets
  * the Sun



Excess testable content is insufficient

- **Problem**:

  Excess testable content is not a sufficient condition for non-ad hoc-ness.

- Take any *explicans* that we would all, or at least Popperians, judge to be ad hoc.

- We can easily turn it into one that they, i.e. Popperians, would deem non-ad hoc.

- This can be done by conjoining to it any random proposition whose testable content exceeds that of the *explicandum*.

Insufficiency: The angered Zeus example

- Suppose Z_1 offers an ad hoc explanation of S_1.

  Z_1: Zeus exists and he is sometimes angry and whenever he is angry he lights up the sky with thunderbolts.

  S_1: Sometimes the sky lights up with thunderbolts.

- Suppose we add a random proposition to the *explicans*. It doesn't matter whether it's T/F. In this case we choose a T:

  A_1: Free falling bodies near the earth's surface accelerate roughly: 9.81m/s^2.

- Following Popper, Z_1 & A_1 is not an ad hoc explanation of S_1 for it has excess testable (and in fact tested) content.

The End