Confirmation Theory (Part I)

- Administrative: I would like to discuss first short paper topics with people sometime in the next week or so.
- Early (Qualitative) Accounts of Confirmation
  - Hypothetico-Deductivism (naive)
  - Instance Confirmation (Hempel)
  - Classic Constraints on Qualitative Confirmation
    - EC, SCC, CC, CCC
- Problems & Paradoxes for the H-D and Hempelian Accounts
  - Raven Paradox
  - Grue Paradox
  - Other Problematic Cases

Preliminaries to Qualitative Confirmation

- The aim of qualitative approaches to confirmation is to provide an analysis (or explication) of "Evidence (or data) E confirms (or supports) hypothesis (or theory) H, in context K."
- Typically, E will be some observation report (*e.g.*, a report concerning the outcome of an experiment intended to test H).
- The "context" K is typically a collection of *background propositions* (*e.g.*, *auxiliary assumptions* or *initial conditions* needed for H to make a prediction about the outcome of an experiment).
- The conjunction $H \& K$ will have *observational consequences*. If H is a statistical hypothesis, then $H \& K$ will only entail *probabilistic* constraints concerning experimental outcomes.
- Early accounts of confirmation presuppose that hypotheses H (together with K) *deductively entail* their observational predictions.

The Hypopthetico-Deductive (H-D) Method I

H. At constant temperature, the pressure of a gas is inversely proportional to its volume (Boyle's Law).

K_1. The initial volume of the gas is (measured to be) 1 ft^3.

K_2. The initial pressure is (measured at) 1 atm.

K_3. The pressure is increased to 2 atm (as measured).

K_4. The temperature (as measured) remains constant.

K_5. Our measuring devices for temperature, pressure, and volume are accurate and reliable (implicit).

E. The volume will (be observed to) decrease to 1/2 ft^3.

- H is the *hypothesis*, K_1–K_4 are *initial conditions*, K_5 is an *auxiliary assumption*, and E is the *prediction* made by H, *given* K_1–K_5.
- NOTE: H *by itself* does not predict anything. It is only when H is supplemented by the *contextual information* K that it can predict E.
- If E is observed, then we say that E *H-D–confirms* H, *relative to* K.

The Hypopthetico-Deductive (H-D) Method II

- The general form of a deductive (*i.e.*, H-D) prediction is:

  H. Hypothesis under test.

  K. Background assumptions (initial conditions, *etc.*).

  E. Observational (deductive) prediction.

- We can also look at the "reverse inference", *from* the observation E *to* the hypothesis H (*given* K). NOTE: this direction is *inductive*!

  E. Observational (deductive) prediction.

  K. Background assumptions (initial conditions, *etc.*).

  ===

  H. Hypothesis under test.

- Of course, an H-D theorist in *not* claiming that E *conclusively* supports (or even *strongly* supports) H, given K. They would concede that the support provided by E (given K) may *not* be strong.

- This is merely a *qualitative* claim, that E confirms H, relative to K.

The Hypopthetico-Deductive (H-D) Method III

- What happens if $\sim E$ is observed instead? In that case, we say that the observation $\sim E$ H-D–*dis*confirms H, relative to K.
- But, where should we place the blame? Why doesn't the observation of $\sim E$ disconfirm K, and leave H unscathed?
- Example: When Newton's theory was applied to the orbit of Uranus, its predictions were *not* observed to be true. But, Newton's theory was not taken to be disconfirmed just yet! The existence of another planet was postulated, and when this assumption was added to K, the predictions of the theory were borne out in observations. This planet (Neptune) was later discovered, thus vindicating Newton's theory.
- Later, when the same thing happened with the orbit of Mercury, attempts to save Newton's theory by postulating another planet failed. This was one of the things that toppled Newtonian gravitational theory.

The Hypopthetico-Deductive (H-D) Method IV

- Typically, auxiliaries are *assumed to be true, for the purpose of testing (competing) hypotheses*. But, even auxiliaries are not sacrosanct, and they may be called into question by further experimental inquiry.
- This problem of *locating the blame* in cases of H-D–*dis*confirmation is known as the *Quine-Duhem Problem*. Quine and Duhem both pointed out that hypotheses do not predict anything in isolation, but only in conjunction with a rich set of auxiliary assumptions.
- Other Problems with the H-D Theory of Confirmation
  - The Problem of Alternative Hypotheses (underdetermination)
  - The Problem of Statistical Hypotheses (*non*-deductive prediction)
  - The Problem of Irrelevant Conjunction (tacking problem)
  - The Problem of Quantitative Generalization

Hempelian "Instance" Confirmation I

- In Hempel's classic "Studies in the Logic of Confirmation" (in reader), he outlines an alternative to H-D (qualitative) confirmation.
- The basic idea (or slogan!) behind this account is:

  "Hypotheses are confirmed by their positive instances."

- What this means, precisely, is not so easy to say!
- Before Hempel, Nicod tried to explain the notion of "positive instance" for universal conditionals (H) having the following logical form:

$$H: \quad (\forall x)(Rx \rightarrow Bx) \qquad [\textit{e.g.}, \text{ all ravens are black}]$$

- According to Nicod, E is an instance of such an H just in case E satisfies both the antecedent and consequent of H (*e.g.*, $Ra \,\&\, Ba$).
- When applied to confirmation, this leads to absurd results …

Hempelian "Instance" Confirmation II

- To see why, consider the following hypothesis:

$$H' : (\forall x)({\sim}Bx \rightarrow {\sim}Rx) \qquad [\textit{e.g.}, \text{all non-black things are non-ravens}]$$

- According to Nicod, $Ra \,\&\, Ba$ *confirms* H *but not* H'. This is *absurd*, since H and H' are *logically equivalent* (*they say the same thing*)!
- This suggests the following *desideratum* for accounts of confirmation:

  Equivalence Condition. If E confirms H, and H is logically equivalent to H' ($H \Leftrightarrow H'$), then E confirms H'.

- Things get *even worse* for Nicod! Consider the following hypothesis:

$$H'' : \quad (\forall x)[(Rx \,\&\, {\sim}Bx) \rightarrow (Px \,\&\, {\sim}Px)]$$

- *Nothing* can satisfy the consequent of H'', and if H is true, then nothing can satisfy the antecedent of H'' either. Therefore, if H is true, then — on Nicod's account — nothing can confirm H''. But, $H \Leftrightarrow H''$!

Hempelian "Instance" Confirmation III

- After giving-up on Nicod's instance account, Hempel laid down the following *desiderata* (in addition to the Equivalence Condition).

  Entailment Condition. If E entails H, then E confirms H.

  Special Consequence Condition. If E confirms H and H entails H', then E confirms H'.

  Consistency Condition. If E confirms H and E confirms H', then H and H' are logically consistent.

  Non-Triviality Condition. For all H, there exists an E which does *not* confirm H.

- Because Hempel accepts all of these desiderata, he *must* (on pain of inconsistency — see paper topics!) reject the following desideratum:

  Converse Consequence Condition. If E confirms H and H' entails H, then E confirms H'.

Hempelian "Instance" Confirmation IV

- Hempel then gave an account satisfying his 5 desiderata. The key definition behind his "instance" account is as follows:
- The *development of a hypothesis* H *for a set of individuals* I [$dev_I(H)$] is (intuitively) "what H says (*extensionally*) about the members of I."
- Formally, $dev_I(H)$ is obtained by (i) *conjoining* all the I-instances (in the naive, Nicod sense) of H, if H is a *universal* ($\forall$) claim, and (ii) *disjoining* all the I-instances of H, if H is an *existential* ($\exists$) claim.
- Examples: Let $I = \{a, b\}$, then we have:
  - If $H = (\forall x)Bx$, then $dev_I(H) = Ba \,\&\, Bb$.
  - If $H = (\exists x)Rx$, then $dev_I(H) = Ra \vee Rb$.
  - If $H = (\forall x)(\exists y)Lxy$, then (working from the outside-in):

$$\begin{aligned} dev_I(H) &= (\exists y)Lay \,\&\, (\exists y)Lby \\ &= (Laa \vee Lab) \,\&\, (Lba \vee Lbb) \end{aligned}$$

Hempelian "Instance" Confirmation V

- Now, we're ready for the definition(s) of *Hempel-confirmation.*
- *E directly-Hempel-confirms H*, relative to background K, just in case $E \,\&\, K \vDash dev_I(H)$ for the class I of individuals mentioned in E.
- *E Hempel-confirms H*, relative to K, iff E directly-Hempel-confirms (rel. to K) every member of a set of sentences S such that $S \,\&\, K \vDash H$.
- Why the two definitions? $Ra \,\&\, Ba$ does *not directly* Hempel-confirm $Rb \rightarrow Bb$, but $Ra \,\&\, Ba$ *does* Hempel-confirm $Rb \rightarrow Bb$ (α-variants).
- Problematic Examples for Hempel's Theory:
  - Let $I = \{a, b\}$, $H = (\forall x)Rxy$, $E = Raa \,\&\, Rab \,\&\, Rbb \,\&\, Rba$, and $E' = Raa \,\&\, Rab \,\&\, Rbb$. E Hempel-confirms H, but E' does not.
  - *No consistent E* can confirm the following, which is *true* on $\mathbb{N}$,

$$(H) \qquad (\forall x)(\exists y)x < y \,\&\, (\forall x)x \not< x \,\&\, (\forall x)(\forall y)(\forall z)[(x < y \,\&\, y < z) \rightarrow x < z]$$

since $\mathrm{dev}_I(H)$ *is inconsistent, for any finite I*! Prove this!

Hempelian "Instance" Confirmation VI

- Two Deeper, Philosophical Problems with Hempel's Account:
  - Paradox of the Ravens: Consider the hypothesis that all ravens are black, H: $(\forall x)(Rx \rightarrow Bx)$. Which of these Hempel-confirms H?

E_1: $Ra_1 \,\&\, Ba_1$	E_2: $\sim Ra_2$	E_3: Ba_3
E_4: $\sim Ra_4 \,\&\, \sim Ba_4$	E_5: $\sim Ra_5 \,\&\, Ba_5$	E_6: $Ra_6 \,\&\, \sim Ba_6$

    Answer: *All but* E_6 *Hempel-confirm* H! *Red Herrings* confirm H?!

  - Goodman's Grue Paradox: Consider the hypothesis that all ravens are "blite", where the predicate "blite" (B) is defined as follows:

    x is blite iff *either* (i) x is examined before (the end of) today, and x is black *or* (ii) x is examined after today, and x is white.

    On Hempel's theory (and, it seems, *any* reasonable "instance" theory) $Ra \,\&\, Ba$ confirms H. But, this means that a black raven observed today confirms the hypothesis that ravens observed tomorrow (and thereafter) will be white! Hume looms large here!