I. Induction, Probability and Confirmation: Introduction

1. Basic Definitions and Distinctions

   * Singular statements vs. universal statements
   * Observational terms vs. theoretical terms

   **Observational statement (E):**
   - singular statement employing only observational terms

   **Hypothesis (H):**
   - statement meant to be tested by examining its observational consequences
   
   [its truth cannot be tested directly because it employs theoretical terms or is a universal statement (or both)]

   **Confirmation** is a relationship of *positive support* between an observation statement E and a scientific hypothesis H (or hypotheses H₁, H₂), relative to a set B of background assumptions.

   We write: E confirms H relative to B.

   • Why not a relation between an object (e.g., a black raven) and a hypothesis (e.g., all ravens are black)?
     [Grasshopper example]

   • Why do we need to bring in background assumptions B?
     [Drug testing example]
2. A puzzle

Why try to understand confirmation if we have not yet solved the problem of induction (and maybe never will)?

Simplest answer: The problem is too important to put off.

We can still formulate criteria that an adequate concept of confirmation should meet.

We can still propose philosophical models (= quasi-formal theories) and test them against these criteria (and particular cases).

3. Three concepts of confirmation.

a. Qualitative concept: E confirms H (relative to B).

b. Comparative concept: E confirms H₁ more than H₂ (relative to B).

c. Quantitative concept: E confirms H (relative to B) to degree p.

Hempel: The qualitative notion is the most basic, and is pre-supposed by the other two.

Carnap: A quantitative notion of confirmation is necessary even to get the qualitative concept right.
II (§§ 2.2 - 2.3) The Hypothetico-Deductive (H-D) Method

A simple and popular qualitative theory of confirmation.

1. Statement of the method

Let E stand for an observational prediction, H for a hypothesis and I for initial conditions.

a. H-D, version 1

E confirms H (relative to I) if:
(i) E follows deductively from H + I;
(ii) E is observed to be true.

E disconfirms H if (i), but E is observed to be false.

Examples: Confirmation of Boyle’s Law; Disconfirmation of corpuscular theories of light by Poisson Bright Spot.

Problem: H +I is not enough. You need auxiliary hypotheses.

Boyle’s law: assumptions about measuring instruments.
LeVerrier (Neptune): no other large masses nearby

b. H-D, version 2 [A ≡ auxiliary hypotheses]

E confirms H (relative to I and A) if:
(i) E follows deductively from H + I + A;
(ii) E is observed to be true.

E disconfirms H (relative to I and A) if (i), but E is observed to be false.

Disconfirmation is complex: you can reject A and/or I instead of H.

Ex: Neptune vs. Vulcan
2. Objections to Hypothetico-Deductive method

i) Problem of alternative hypotheses (underdetermination).

Any finite set of observations “confirms” infinitely many hypotheses.

   [curve-fitting problems]
   [Goodman’s grue/bleen problem]

Usual “solution”: choose the simplest hypothesis.

The real problem: No place for simplicity in H-D method

More broadly: No criteria for plausibility, or for degree of confirmation, to let us ignore hypotheses that are ridiculous, even though technically ‘confirmed’ by E.

ii) Problem of statistical hypotheses.

If H is statistical (ex: ‘this coin is fair’), then E cannot be derived deductively from H + I + A, but only the probability of E (or a range of outcomes including E).

Usual “solution”: methodological assumptions (significance tests)

iii) Importance of variety of evidence.

New types of evidence should count for more, but H-D doesn’t distinguish strength of confirmation

iv) No cumulative tracking of confirmation (no degree of confirmation that changes over time).

Question: Are these ‘fatal’ objections to the H-D method?
III. (§ 2.4) Hempel’s theory of confirmation

A qualitative theory of confirmation for simple cases like “All ravens are black”.

[Addresses problem of alternative hypotheses, but not the other problems]


Requirements for an acceptable analysis of “E confirms H”:

a) Equivalence condition. If H and H’ are logically equivalent and E confirms H, then E confirms H’.

b) Entailment condition. If E implies H, then E confirms H.

c) Special consequence condition. If E confirms H and H logically implies H’, then E confirms H’.

d) Consistency condition. If E confirms both H and H’, then H and H’ are consistent.

Hempel rejects:

e) Converse consequence condition. If E confirms H, and H’ logically implies H, then E confirms H’.

[Adding e) to a) – d) leads to: any E confirms any H.]

Question: Which of a) – e) are really appropriate requirements for a theory of confirmation?
2. **Nicod’s criterion.**

All and only statements of the form $Ra \cdot Ba$ confirm $(x)(Rx \supset Bx)$.

"$a$ is a black raven" confirms "All ravens are black."

**Objection.** Violates equivalence condition.

$$(x)(\sim Bx \supset \sim Rx)$$
$$(x)((Rx \cdot \sim Bx) \supset (Ax \cdot \sim Ax))$$

are equivalent to $(x)(Rx \supset Bx)$, but are NOT confirmed by $Ra \cdot Ba$.

[No easy fix: see note 3, page 50]

**Response.** Amend Nicod’s criterion by treating it as giving us a *sufficient* condition for confirmation (and one more requirement for an adequate account of confirmation):

**Nicod:** Statements of the form $Ra \cdot Ba$ confirm $(x)(Rx \supset Bx)$.

**Remark.** Nicod’s criterion in combination with Hempel’s other criteria leads to the famous **Paradox of the Ravens**.

1. $\sim Ra$ and $\sim Ba$ confirms $(x)(\sim Bx \supset \sim Rx)$ [By Nicod]
2. $(x)(\sim Bx \supset \sim Rx)$ equivalent to $(x)(Rx \supset Bx)$ [by logic]
3. $\sim Ra$ and $\sim Ba$ confirms $(x)(Rx \supset Bx)$ [Equivalence condition]
4. $\sim Ra$ and $\sim Ba$ does NOT confirm $(x)(Rx \supset Bx)$
   [(4) appeals to intuition: no armchair ornithology!]

(3) and (4) constitute a contradiction.
3. Hempel’s positive account.

i) Development of a hypothesis in a finite domain.

Universal statements become conjunctions. Existential statements become disjunctions.

If domain \( D = \{a, b, c\} \):

a) \( H_1 \equiv \) All swans are white. \((x)(Sx \supset Wx)\)
\[\Rightarrow (Sa \supset Wa) \cdot (Sb \supset Wb) \cdot (Sc \supset Wc)\]
\[\text{dev}_D(H_1)\]

b) \( H_2 \equiv \) Some swan is white. \((\exists x)(Sx \cdot Wx)\)
\[\Rightarrow (Sa \cdot Wa) \lor (Sb \cdot Wb) \lor (Sc \cdot Wx)\]
\[\text{dev}_D(H_2)\]

ii) Definition of confirmation.

a) \( E \) directly confirms \( H \) if \( E \) logically implies \( \text{dev}_D(H) \), where \( D \) is the set of all individuals mentioned in \( E \).

\( Ra \cdot Ba \) directly confirms \( (x)(Rx \supset Bx) \).
\( \sim Ra \cdot \sim Ba \) directly confirms \( (x)(Rx \supset Bx) \).
\( Ra \cdot Ba \) does NOT directly confirm \( Rb \supset Bb \), if \( b \neq a \).

b) \( E \) confirms \( H \) if \( E \) directly confirms every member of a set of sentences \( K \) such that \( K \) logically implies \( H \).

\( Ra \cdot Ba \) confirms \( (Rb \supset Bb) \) \([\text{take } K \text{ as just } (x)(Rx \supset Bx)]\)

iii) Virtues of Hempel’s model.

- satisfies his criteria
- very simple
- agrees with common-sense cases (esp. Nicod’s criterion)

iv) Weaknesses.

1. Only for generalizations formulated with observational terms – no account of confirmation for theoretical hypotheses.

2. May be too strict (example, p. 52).

3. Too liberal: In Ravens Paradox and Goodman’s problem, Hempel finds confirmation where there should be none.

[Note: Bayesians face same problems and offer solutions using degree of confirmation – not available to Hempel.]
IV. (§2.5) Hume’s problem of induction

[Covered in week 1]

Hume’s conclusion: no *logical (rational) basis* for placing confidence in any scientific prediction. Only psychology: custom or habit.
V. (§2.6) Answers to Hume

1. Inductive Justification (success of science)

Induction has worked well in the past, so it is rational to rely on induction in the future.

**Objection:** circular reasoning (or infinite regress).

**Rule R (enumerative induction):**

Most A’s have been B’s.

So, the next A will (probably) be a B.

The argument relies upon rule R (A \equiv cases of using the rule R, B \equiv successful prediction) to justify continued use of R. To use a rule to justify itself is vicious circularity. Compare:

**Rule C (Crystal ball gazing).** The poor record of Rule C is not a problem if we use rule C to justify itself.

**Rule D (counterinductive rule):**

Most A’s have not been B’s.

So, the next A will (probably) be a B.

The poor record of Rule D is an asset if we use D to justify itself.
2. Ordinary Language Dissolution

To be rational means to form beliefs based on available evidence (inductive or deductive).

To use induction just is to form beliefs based on the available inductive (empirical) evidence.

So: the question, “Is it rational to use induction?” amounts to “Is it rational to be rational?”, which is trivial.

Induction is rock-bottom. There is no more basic principle from which induction could be justified.

**Objection:** this reply to Hume trades on ambiguity.

Rational$_1 = vindication$: a rule is rational$_1$ if it achieves its purpose.

Rational$_2 = validation$: a rule is rational$_2$ if derived from some other justified rule.

Induction cannot be validated. But it might be vindicated.

The question becomes: is it rational$_1$ to be rational$_2$ (using accepted rules of induction)? That is non-trivial.

3. Goodman and Inductive Intuition

Goodman (Fact, Fiction and Forecast) raised a parallel question: how is deductive inference justified? He suggested a parallel to Hume’s argument: no deductive justification (circular); no inductive (not ampliative), so not justified?

**Proposal:** justification for a rule of reasoning (deductive or inductive) is to confront particular cases (intuition) with the conclusions reached by those rules.

**Objection:** the parallel fails. We are talking about vindication.

For deduction, we can demonstrate that true conclusions must follow from true premises. Rules like MP are vindicated. We reject rules like affirming the consequent, where this is not guaranteed.

Main point: general considerations, not psychology, are brought to bear in deciding which rules (deductive or inductive) achieve their purpose.
5. **Pragmatic justification**

**Strategy:** the adoption of the standard inductive rule (enumerative induction) will work IF ANYTHING will work.

<table>
<thead>
<tr>
<th>Nature is uniform</th>
<th>Nature not uniform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use induction</td>
<td>success</td>
</tr>
<tr>
<td>Use other method</td>
<td>success or failure</td>
</tr>
</tbody>
</table>

Formally:

1. Either nature is sufficiently uniform to make successful inductive inferences or not.
2. If it is uniform: induction will work, and other methods might work.
3. If not uniform: no method can work (else inductive method would share in its success – since that success would constitute a uniformity).

SO: since induction is no worse (and possibly better) than any other method, we should use induction.

A **deductive** argument and a vindication of induction.

**Objections:**

1) Vagueness of “nature is uniform”
2) Vagueness of “use induction”

If we make these precise, there are TOO MANY rules that do “as well” as induction.