

Induction and Confirmation

Christian Wüthrich

<http://philosophyfaculty.ucsd.edu/faculty/wuthrich/>

145 Philosophy of Science
Class 8, 24 April 2008

The Mother of All Problems...

- logical empiricism: confirmation as abstract relation between sentences
- important role: “inductive” inference
- justification impossible due to Hume's **problem of induction**
- confirmation not just relevant in cases of traditional induction (inferences from observed whiteness of swans to hypothesis that all swans are white), but also in cases such as how observational data supports Copernicus' heliocentric theory, how fossil records confirm Darwin's theory of evolution etc

Types of non-deductive inferences

- 1 **induction narrowly construed** or **enumerative induction**: Swan 1 observed at time t_1 was white, swan 2 observed at time t_2 was white... \Rightarrow All swans are white
- 2 **projection**: Swan 1 observed at time t_1 was white,... swan $n - 1$ observed at time t_{n-1} was white \Rightarrow Swan n (the next one to be observed) will be white
- 3 **abduction, inference to the best explanation, or explanatory inference**: data \Rightarrow hypothesis about a structure or process that would "explain" the data

debate about which non-deductive inference is most basic:
Reichenbach (induction) vs. Harman (abduction)

Nota bene: I will use the term "induction" to refer to the first two types of inference above.

David Hume's problem of induction

Hume, *Enquiry*, Section V

- relations of ideas vs. matters of fact
- relations of ideas: can be known independently of observation, abstract realm of logic and mathematics, all analytic *a priori* beliefs
- matters of fact: everything that is not a relation of ideas, concerns material existence, synthetic knowledge
- matters of fact can be observed (e.g. “there is a desk here”), or unobserved (e.g. “the sun will rise tomorrow”)
- In order to know any matter of fact beyond what is directly given by our sensory experience, inductive reasoning must be employed.

- Inductive inferences depend on a “principle of the uniformity of nature”: past acts as reliable guide to the future.
- Hume argues that such a principle cannot be justified; rational justification, were we to have it, could come in two different forms:
 - ① demonstrative, *a priori* reasoning; but future does not depend logically on past bc it is conceivable that future does not resemble past; cannot ground induction in *a priori* reasoning
 - ② inductive reasoning: our past success in using inductive inference warrants inductive inferences into the future; circular!
- Conclusion: inductive practices have no rational foundation.

A brief introduction to confirmation theory

- general goal of confirmation theory: to solve the problem of induction
- more precisely: we have seen that predictions about the future, as well as unrestricted universal generalizations are not logically implied by observational evidence, bc the latter is always only about particular facts in the present and the past
- nevertheless, there is a sense in which observing white swans **confirms** the hypothesis that the next observed swan is white, and that all swans are white
- confirmation theory is the, sometimes formal, attempt to make sense of such confirmation in the wake of the problem of induction

Models of confirmation of scientific hypotheses

Model (Instantial model of inductive confirmation)

A hypothesis of the form “All F’s are G” is supported by its positive instances, i.e. by observed F’s that are also G.

(This is sometimes called [Nicod confirmation](#))

Problems:

- observed instances not necessary for inductive support: inference to unobserved entities
- Hempel's paradox of the ravens (to be explained shortly)
- Goodman's “new riddle of induction” (to be explained shortly)

Model (Hypothetico-deductive model of confirmation (Hempel))

A hypothesis or theory is confirmed if it, together with auxiliary statements, deductively entails a datum.

Question: does this sound familiar?

Attractive features:

- allows for confirmation of hypotheses that appeal to unobservable entities and processes, as long as it has observable consequences
- “reduces” inductive inferences to much better understood deductive principles
- seems to genuinely reflect scientific practice, it's “the scientists’ philosophy of science” (Lipton, p. 422)

Problems of the hypothetico-deductive model

1 Glymour 1980:

(A)

- any theory T deductively implies $T \vee S$ where S is any statement
- $T \vee S$ can be conclusively established by observing the truth of S
- if S is observational, then we can establish $T \vee S$ by observation, which confirms T

(B)

- if theory T implies observation E , then theory $T \& S$ implies E as well
- so $T \& S$ is confirmed by E
- but S was entirely arbitrary

2 Hempel's paradox of the ravens

3 Goodman's "new riddle of induction"

Hempel's raven paradox

Two important principles of confirmation:

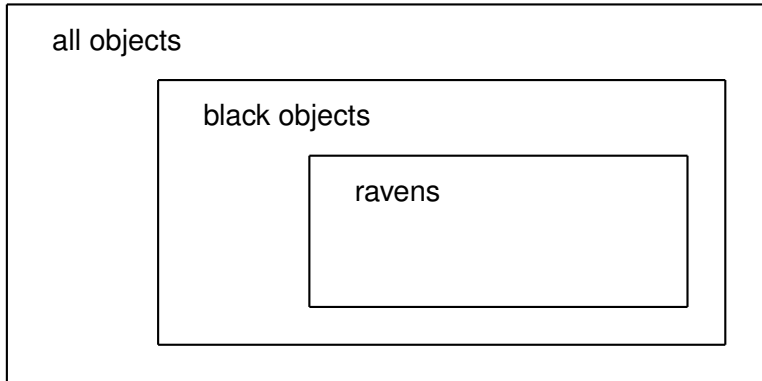
- 1 **Equivalence condition:** if evidence E confirms hypothesis H_1 , and hypothesis H_2 is logically equivalent to H_1 , then E also confirms H_2
- 2 **Instance condition:** universal generalizations are confirmed by their positive instances

To illustrate the instance condition, consider the universal generalization

H_1 : "All ravens are black."

Pedantically, H_1 asserts that: For any x , if x is a raven, then x is black.

Diagrammatically:



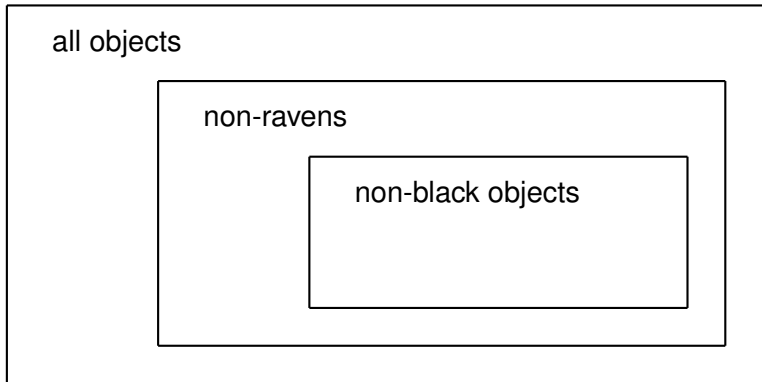
- Let E_1 be the evidence that object a is a raven and that a is black.
- Since the object a satisfies both the antecedent and the consequent of the ravens hypothesis H_1 , we have a positive instance of H_1 .
- By the instance condition then, E_1 confirms H_1 .

Now consider the generalization

H_2 : “All non-black things are non-ravens.”

Pedantically, H_2 asserts that: For any x , if x is not black, then x is not a raven.

Diagrammatically:



- Let evidence E_2 be the evidence that b is white and that b is a shoe.
- Since b satisfies both the antecedent and the consequent of H_2 we have a positive instance.
- So by the instance condition E_2 confirms H_2 .
- But note that H_2 is logically equivalent to H_1 .
- So by the equivalence condition, E_2 confirms H_1 , i.e. a white shoe confirms “All ravens are black”!
- Does this mean that indoor ornithology is possible?

Resolutions

- 1 reject equivalence condition **not very attractive**
- 2 reject instance condition **not very attractive, but we might modify it...**
- 3 H_1 about *ravens*, so E_2 does not really confirm it \Rightarrow **test** or **relevance requirement**: objects must be **potential falsifiers**; ravens are potential falsifiers, but shoes are not (but universal quantifier; order is important! cf. Godfrey-Smith p. 49f)
- 4 swallow consequence:
 - a consider H_3 : "All sodium salt burns yellow," but chemical at issue does not burn yellow, and subsequent analysis shows that it's not sodium salt \Rightarrow may count as weak confirmation, although analogous to raven example
 - b in our world, set of non-black things \gg set of ravens; E_2 exhausts a little bit of instances and thereby confirms H_1 a little bit; possible world with ravens \gg non-black objects \Rightarrow more confirmation (Hempel's reply)

But next paradox suggests rejection of instance condition...

Goodman's "new riddle of induction"

Consider the following argument:

(E_1) raven a_1 & black a_1

(E_2) raven a_2 & black a_2

...

$(E_{10,000})$ raven $a_{10,000}$ & black $a_{10,000}$

(H_1) All ravens are black.

Now consider the alternative argument:

(E_1) raven a_1 & blite a_1

(E_2) raven a_2 & blite a_2

...

$(E_{10,000})$ raven $a_{10,000}$ & blite $a_{10,000}$

(H_4) All ravens are blite.

Gruesome predicates

The second argument used a new predicate:

Definition (Blite)

An object is blite iff it was first observed before 2010CE and is black, or if it was not first observed before 2010CE and is white.



Objects do *not* have to change colour in order to be blite!

If all evidence E_1 through $E_{10,000}$ is based on observation made before 2010CE, then the second argument should be considered as good as the first...

Resolutions

- 1 reject instance condition
- 2 only allow “projectable” predicates, i.e. ones not needing a reference to a particular time, or ones that are parasitic on other predicates (black and white in this case)
- 3 base predicates in language on “natural kinds”

Problem with second resolution:

Definition (Whack)

An object is whack iff it was first observed before 2010CE and is white, or if it was not first observed before 2010CE and is black.

Now consider blite and whack as basic and black and white as parasitic...

Definition (Black)

An object is black iff it was first observed before 2010CE and is blite, or if it was not first observed before 2010CE and is whack.

Application: curve-fitting problem

There's always an infinity of mutually contradictory hypotheses that fit the data, but which is best confirmed? [see blackboard]

Other approaches to confirmation

- Carnap's application of the mathematical theory of probability and its present-day successor theory of Bayesianism
- models of causal inference (from effects to their probable causes), such as Mill's "methods of experimental enquiry" [cf. history of philosophy of science]
- learning theory
- ...