

Metaphysics & Epistemology

Abduction

Modes of Inference

- According to C.S.Peirce, there are three modes (types) of inference:
 - Deduction
 - Induction
 - Abduction

Peirce on Abduction

- According to Peirce, abduction or the “operation of adopting an explanatory hypothesis” can be schematized as follows:

(A-P)

Premise1: The surprising fact *C* has been observed.

Premise2: But if *A* were true, *C* would be a matter of course.

Conclusion: Hence there is reason to suspect that *A* is true

Abduction

- A-P classifies abduction as a type of **non-monotonic** reasoning. The observation of the fact C gives us reason to adopt hypothesis A , which, in turn, describes a completely different fact.
- Of course, A-P, qua mode of reasoning, is too general. It leaves open whether A was generated from our previous knowledge or whether it was chosen from an already known set of hypotheses.
- In the first case, abduction is **creative**, while in the second it is **selective**.

Abduction

- Furthermore, A-P gives us another degree of freedom, namely, the relation between A and C . For example, A may be an **explanation** of C or C may simply **follow logically** from A .
- In the first case, the abductive inference establishes the conclusion based on the explanatory power of A , while in the second, the conclusion follows solely on the basis of the fact that A implies it.
- In this course, the focus is on the selective part of abductive reasoning.

Inference to the Best Explanation

- The hypotheses that may serve as possible solutions to an abductive problem are evaluated based on their merits qua potential explanations in such a way that the chosen hypothesis is **the one that scores best**.
- This kind of abduction, known as **Inference to the Best Explanation** [IBE], may be found in many variations, but a typical version of it can be schematized as follows:

IBE

Premise1: D is a collection of data.

Premise2: H explains D .

Premise3: No other hypothesis can explain D as well as H does.

Conclusion: Therefore, H is probably/possibly/approximately true.

IBE in everyday life (I)

- Yesterday morning, Alice observed that the lawn outside her home, was wet.
- Rain is the best explanation for the wet lawn.



- Hence, it probably rained.

IBE in everyday life (II)

- Bob observed footprints in the sand, in an empty beach.
 - The best explanation for the footprints is that someone was there.
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- Hence, someone walked on the beach before the arrival of Bob.

IBE in science

- Charlotte is coughing, suffers from headaches and she did a Covid test that was positive.
 - The best explanation of these data is that she suffers from Covid.
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- So, she probably suffers from Covid.

IBE in philosophy

- Our mature scientific theories are successful.
 - The best explanation for the success of our mature scientific theories is that they are (approximately) true.
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- Hence, our mature scientific theories are (approximately) true.
- This is a well-known philosophical argument that plays a crucial role in the realism/antirealism debate. It is called the **No-Miracle Argument**.

Recall...

Premise1: D is a collection of data.

Premise2: H explains D .

Premise3: No other hypothesis can explain D as well as H does.

Conclusion: Therefore, H is probably/possibly/approximately true.

IBE and explanatory virtues

- The first premise allows for D to be a collection of data, i.e., a fact, a collection of facts, a law, or even a whole theory.
- The second premise guarantees that the chosen hypothesis can be a legitimate explanation of D .
- The most crucial premise is the third: there must be a way to evaluate and rank competing explanations in order to decide whether the chosen hypothesis is better than the others.
- **Explanatory virtues** serve this role, by ranking competent hypotheses according to their explanatory power.

Whither explanatory virtues?

- Kuhn (1977): accuracy, consistency, scope, simplicity, fruitfulness
- Quine & Ullian (1978): simplicity, familiarity, scope, fecundity
- Thagard (1978): consilience, simplicity, analogy
- McMullin (1982): predictive accuracy, internal coherence, external consistency, unifying power, fertility, simplicity
- Psillos (2002): consilience, completeness, importance, parsimony, unification, precision
- Lipton (2004): mechanism, precision, scope, simplicity, fertility, fit with background belief

Whither explanatory virtues?

- McMullin (2008): empirical fit, empirical adequacy, explanatory power, internal consistency, internal coherence, simplicity, external consistency, consonance, optimality, fertility, consilience, durability
- Mackonis (2011): coherence, breadth, depth, simplicity, empirical adequacy, unification
- Keas (2018): evidencial accuracy, causal adequacy, explanatory depth, internal consistency, internal coherence, universal coherence, beauty, simplicity, unification, durability, fruitfulness, applicability
- ...

Whither explanatory virtues?

- Some of the virtues mentioned are, nowadays, taken to be complex, that is, to include two or more major virtues. Kuhn's consistency, for instance, splits into internal consistency and external consistency.
- Virtues with the same meaning but different name: e.g. Thagard's *consilience* is close to McMullin's notion of *unification*.
- Virtues with the same name but different meaning: Thagard's *consilience* is way different than Psillos' *consilience*.

Whither explanatory virtues?

- *Consilience*: Suppose that there are two potentially explanatory hypotheses H1 and H2 but the relevant background knowledge favours H1 over H2. Unless there are specific reasons to challenge the background knowledge, H1 should be accepted as the best explanation.
- *Completeness*: Suppose that only one explanatory hypothesis H explains all data to be explained. That is, all other competing explanatory hypotheses fail to explain some of the data, although they are not refuted by them. H should be accepted as the best explanation.

Whither explanatory virtues?

- *Importance*: Suppose that two hypotheses H1 and H2 do not explain all relevant phenomena, but that H1, unlike H2, explains the most salient phenomena. Then H1 is to be preferred as a better explanation.
- *Parsimony*: Suppose that two composite explanatory hypotheses H1 and H2 explain all data. Suppose also that H1 uses fewer assumptions than H2. In particular, suppose that the set of hypotheses that H1 employs to explain the data is a proper subset of the hypotheses that H2 employs. Then H1 is to be preferred as a better explanation.

Whither explanatory virtues?

- Internal consistency: An **internally consistent** theory is a theory consistent per se or with the narrow background knowledge in the context of which it operates.
- *External consistency*: A theory is **externally consistent** if it is consistent with the most accepted or well-confirmed scientific theories.
- *Precision*: Suppose that H1 offers a more **precise** explanation of the phenomena than H2, in particular an explanation that articulates some causal-nomological mechanism by means of which the phenomena are explained. Then H1 is to be preferred as a better explanation.

Whither explanatory virtues?

There are three different versions of simplicity: syntactical, ontological, and algebraic.

- A theory is **syntactically simpler**, or more *elegant*, if it explains all the data using a smaller set of hypotheses than its competitors.
- **Ontological simplicity** may be split in two subcategories, qualitative and quantitative. A qualitatively simpler theory uses fewer different kind of entities than its competitors. Similarly, a quantitatively simpler theory uses a smaller number of entities than its competitors.
- **Algebraic simplicity** applies to curve-fitting problems, where the best solution is the polynomial function with the smaller degree.

Objective vs Subjective virtues

- It is perfectly clear what it means for a hypothesis to be syntactically simpler or internally consistent, it remains unclear how the agent evaluates the *importance* of the phenomena it explains or the *external consistency* of a theory. For suppose that the incompatible hypotheses $H1$ and $H2$ explain the different sets of data $E1$ and $E2$, respectively.
- How should the scientist choose between them? A quantum theorist may well favor $H1$ as it works better for the microscopic phenomena, while an astrophysicist may choose $H2$, as it is in agreement with the macroscopic ones. That is, each scientist may evaluate differently which phenomena are more important, ending up with a different classification of the hypotheses at hand, according to the virtue importance.

Weighing the virtues

- It is an open question how we can come up with a classification of the explanatory virtues according to their significance.
- The scientist should know which virtues are more significant than the others.

Recall...

Enumerative Induction [EI]:

The 1st A shares property B.

.....

The n-th A shares property B.

All A's are B.

El is a subcase of IBE (Harman)

Every A that has been observed, shared property B.

The best explanation is that all A's are B.



All A's are B.

IBE is (?) a subcase of EI (Fumerton)

There are footprints on the beach.

If someone walked the beach recently, there would be such footprints.

Someone walked the beach recently.

In all cases in which we have observed footprints on the beach, someone was present just prior to the existence of such footprints.

Here is another case of footprints on the beach.

Someone walked the beach recently.

Objections (I)

- Van Fraassen (1989, 142-143):
- “It purports to do this on the basis of an evaluation of hypotheses with respect to how well they explain the evidence, where explanation again is an objective relation between hypothesis and evidence alone. It cannot be that for it is a rule that only selects the best among the historically given hypotheses. We can watch no contest of the theories we have so painfully struggled to formulate, with those no one has proposed. So our selection may well be the best of a bad lot.”

Objections (I)

- Van Fraassen (1989, 146):
- “I believe, and so do you, that there are many theories, perhaps never yet formulated but in accordance with all evidence so far, which explain at least as well as the best we have now. Since these theories can disagree in so many ways about statements that go beyond our evidence to date, it is clear that most of them by far must be false. I know nothing about our best explanation, relevant to its truth-value, except that it belongs to this class. So I must treat it as a random member of this class, most of which is false. Hence it must seem very improbable to me that it is true.”

Objections (I)

- P1: the best theory (which is the outcome of an IBE syllogism) explains well the data in D.
 - P2: There are many theories that have not yet been formulated, which explain equally well or even better than H the observations that constitute the set D. Moreover, these theories are potentially distinguishable from each other, as well as from H. Let \mathcal{H}^* the set where these theories belong to.
 - P3: We currently don't know anything that distinguishes H from the members of \mathcal{H}^* .
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- C: Therefore, it is more likely that the true hypothesis is among the members of \mathcal{H}^* .

Objections (II)

Van Fraassen (again!):

- Either IBE reduces to the Bayes rule, or it significantly differs from Bayes rule.
- In the first case, IBE is redundant. In the second, IBE is incompatible with the probability calculus.