

COMPARING TWO APPROACHES TO ASSESSING EXPLANATORY POWER: INFERENTIAL CONTENT VS. STATISTICAL RELEVANCE

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PLAN

- Some preliminaries: the talk about explanatory power in philosophy of science
- Advantages and disadvantages of the statistical relevance approach
- The proposal to assess explanatory power in terms of the inferential content
- Summary and conclusions

THE TALK ABOUT EXPLANATORY POWER IN PHILOSOPHY OF SCIENCE: HEMPEL & OPPENHEIM, 1948

$$S(T, K) = \frac{K1}{K2}$$

$S(T, K)$ – the systematic power of a theory T in respect to a set of data K

$$(T, K2) \vdash K1 \quad (K1, K2) \in K$$

For Hempel “systematic power” accounts for both theory’s explanatory power and its predictive power in respect to particular data K (which it either explains or predicts).

He is probably the first who relates explicitly “explanatory power” to “empirical content”: “.... The very convention that renders the hypothesis irrefutable also drains it of all empirical content and thus of explanatory power” (Hempel, 1965, p. 167).

THE TALK ABOUT EXPLANATORY POWER IN PHILOSOPHY OF SCIENCE: POPPER, 1959

$$E(x, y) = \frac{P(y,x) - P(y)}{P(y,x) + P(y)}$$

$E(x, y)$ – the explanatory power of x with respect to y

$P(y, x)$ – the probability of y given x

“ $E(x, y)$ may also be interpreted as a non-additive measure of the dependence of y upon x , or the support given to y by x (and vice versa)” (Popper, 1959, p. 416) .

THE TALK ABOUT EXPLANATORY POWER IN PHILOSOPHY OF SCIENCE: VAN FRAASSEN, 1980

- “A theory is said to have explanatory power if it allows us to explain” (van Fraassen, 1980, p. 97).
- It seems as if van Fraassen identifies explanatory power with the general explanatory goodness of a given explanans: if a theory A explains particular data D better than a theory B, we may say that the theory A has a bigger explanatory power than the theory B.
- He criticizes the approaches which identify the goodness of explanation (and thus its explanatory power) with the strength with which an explanans predicts a given explanandum as for van Fraassen explanatory power is “radically context-dependent”.

THE TALK ABOUT EXPLANATORY POWER IN PHILOSOPHY OF SCIENCE: LIPTON, 2004

Lipton has identified explanatory power with what he called “the loveliness” of explanation:

- “By showing that many apparently unrelated events flow from a single source and many apparent coincidences are really related, such a theory may have considerable explanatory power. If only it were true, it would provide a very good explanation. That is, it is lovely.” (Lipton, 2004, p. 60)

THE TALK ABOUT EXPLANATORY POWER IN PHILOSOPHY OF SCIENCE: SUMMARY

- All authors who use the term “explanatory power” (EP) relate it in one or another way to the goodness of explanation. (Van Fraassen seems to identify EP entirely with goodness of explanation).
- Two approaches to the definition of explanatory power:
 - An explanans is more powerful if it makes the explanandum more expected or probable (e.g. Popper)
 - An explanans is more powerful if it explains more (e.g. Hempel, Lipton, but the views belonging to this approach vary significantly).

RECENT VERSIONS OF THE STATISTICAL RELEVANCE APPROACH

- Schupbach & Sprenger, 2011; Schupbach, 2011; Crupi & Tentori, 2012; Eva & Stern, 2018; Sprenger & Hartmann, forthcoming;

According to the SR approach, explanatory power is

- a measure of the strength of an explanation (of the degree to which an explanatory hypothesis h decreases the unexpectedness of the explained event e);
- best captured by the notion of statistical relevance;
- a function of $p(e|h)$ and $p(e)$;
- not dependent on a particular model of explanation.

ADVANTAGES OF THE STATISTICAL RELEVANCE APPROACH

- Allows for a precise formal explication of the measure of explanatory power and thus for drawing precise and testable predictions about whether a given explanation will be perceived as strong or weak, or stronger/weaker than another explanation, under certain conditions;
- Descriptive adequacy (in some cases); however, as Cohen stated, “testing in a diverse range of empirical situations needs to be performed before we can assess accurately the relative merits [of these measures]”. (Cohen, 2016, p. 1088)

DISADVANTAGES OF THE STATISTICAL RELEVANCE APPROACH

- (1) Probabilistic measures of EP are not applicable to cases where statistical information is either unavailable or there are difficulties to assess it (Glymour, 2015);
- (2) The belief that good explanations always increase the expectedness of explained phenomena is biased (Jeffrey, 1969; Salmon, 1971);
- (3) There are studies showing that statistical relevance is only one of the factors that influence judgements of explanatory power (Johnson et al., 2014; Colombo et al., 2017);
- (4) The applications of the probabilistic measures of EP do not seem truly independent from the assumed model or theory of explanation.

THE USES OF PROBABILISTIC MEASURES OF EXPLANATORY POWER COULD BE INFLUENCED BY THE ASSUMED MODEL OF EXPLANATION

- Schupbach and Sprenger (2011) have stressed that their measure of EP can be applied only when one already knows that **h** explains **e** (see also Sprenger & Hartmann, forthcoming).
- However, **h** might explain **e** according to one theory of explanation and might not do so according to a different theory of explanation. This means that the applicability of ϵ to a particular **(e, h)** depends on the preferred theory of explanation. If the latter leads to a wrong conclusion about the explanatoriness of **h** in respect to **e** that will result in a wrong assessment of ϵ **(e, h)**.
- Example: if we (wrongly) assume that the indications of the barometer explain the storm we will assign a very high EP to this “explanation”.

AN ALTERNATIVE: ASSESSING EXPLANATORY POWER IN TERMS OF INFERENTIAL CONTENT

The logic behind the IC (inferential content) approach:

If we assume (as many do) that

(1) Good explanations increase our understanding of explained phenomena;

and

(2) Understanding is best described in terms of the inferences one can draw about the phenomenon which is understood;

Then we are entitled as well to assume that

(3) Good explanations allow for drawing extra-inferences about the explained phenomena;

WHAT DOES IT MEAN FOR AN EXPLANATION TO HAVE EXPLANATORY POWER ACCORDING TO THE IC APPROACH?

If we paraphrase van Fraassen's "A theory is said to have explanatory power if it allows us to explain" we may say

- An explanation has explanatory power if it adds inferential content

i.e.

$$IC (E(e, h)) > IC (e \& h)$$

or

$$IC (e \text{ because } h) > IC (e \& h)$$

This condition rules out the conjunction problem and thus it explains why a conjunction of several explananda is not explanatory although it "unifies" these explananda and implies any of them.

SOME CHARACTERISTICS OF THE IC APPROACH TO ASSESSING EXPLANATORY POWER

- It is rather **qualitative**;
 - It is possible in principle to count the extra-inferences which a new explanation allows for but it is unclear whether this count is useful; what really matters is the type of inferences an explanation allows for (are they interesting/important, testable etc.)
- It is **context-sensitive**: the inferences an explanation allows for depend on the knowledge and the abilities of the inference-maker;

EXAMPLE: 'Jenny bought a vase which she did not need because Jenny has an impulsive personality'. This explanation allows for ruling out some alternative explanations (e.g. Jenny bought the vase for a present) but one can draw such an inference only if (s)he knows about such alternative explanations.

- Although it is not based on a quantitative measure, the IC approach is a **useful tool for comparing hypotheses** (an example follows).

EXAMPLE: J. J. THOMSON'S CHOICE OF AN EXPLANATION OF THE CATHODE RAYS (1)

- In 1857 Julius Plücker discovered the so-called cathode rays;
- It was found soon that these rays possess a strange combination of properties: they pass through the vacuum, cast shadows, charge negatively metal plates, get deflected by a magnetic field, and have a speed much lower than the speed of light;
- Two hypotheses were formed to explain these properties (but none succeeded to explain all of them):
 - Cathode rays are waves similar to light;
 - Cathode rays consist of negatively charged particles;

EXAMPLE: J. J. THOMSON'S CHOICE OF AN EXPLANATION OF THE CATHODE RAYS (2)

- In 1897 J. J. Thomson assumed that the cathode rays are particles and devised an experiment to measure their mass; this eventually led to the discovery of the electron.
- J. J. Thomson explained his decision to embrace the particle hypothesis in the following way:
 - “[the particle theory] is definite and its consequences can be predicted; with the aetherial theory it is impossible to predict what will happen under any given circumstances, as on this theory we are dealing with hitherto unobserved phenomena in the aether...”

COMPARING THE INFERENTIAL CONTENT APPROACH TO THE STATISTICAL RELEVANCE APPROACH

	SR approach	IC approach
Requires information which is often unavailable	YES	NO
Based on the (biased) idea that the quality of an explanation positively correlates with its strength.	YES	NO
Tested for empirical adequacy	YES (modest support)	NOT YET
Independency from any particular model of explanation	TO SOME EXTENT (the reliance on an inappropriate model may lead to false positives)	TO SOME EXTENT (the reliance on an inappropriate model may screen off some interesting extra-inferences)
Context-sensitivity	NO (but it might be done)	YES
Solves an important problem	?	YES (naturally rules out the conjunction problem)

SUMMARY, OPEN QUESTIONS, CONSTRAINTS

- The IC approach has some advantages over the SR approach:
 - relies entirely on the available information; thus it is easier to use it as a heuristic and/or a normative tool;
 - takes into account the context (the knowledge of the explainer);
 - rules out non-explanatory conjunctions and other “strong” (according to the SR model) explanations by showing that they do not add any inferential content;
 - Explains why people prefer some specific types of explanation (e.g, causal explanations) – because they allow for specific inferences to be drawn, which often turn to be useful.
- The lack of a precise formal explication creates some difficulties for testing the IC approach for descriptive adequacy.

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