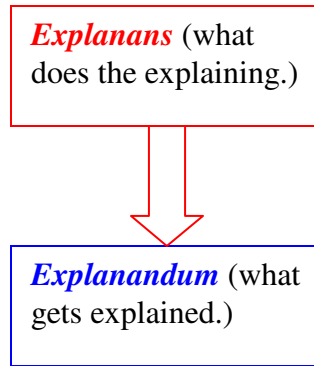

Scientific Explanation



- **Note1:** The ‘classic’ literature on this issue (Hempel, Carnap) came from the school of logical empiricism (and its earlier antecedent: the “Vienna Circle” of logical positivists¹). Such a tradition ascribed to the *sentential/syntax* view of scientific theories: that they can be reduced to sets of sentences in some logically regimented language Λ (usually, but not always, FOPL²). Hence, for instance, Hempel speaks of the explanans and explananda in terms of sentences or more generally *propositions*³ which can in principle be exchanged *ceteris paribus* (all things being equal) with classes of sentences. (Hempel)

Rudolf Carnap: “The Value of Laws”

- “Why-questions” arising in science should be ‘answered’ if they can be placed in some framework of **empirical laws**, otherwise they should be relegated as ‘metaphysical’. CC1998, 678

“[F]or the explanation of a given fact, **the use of a scientific law is indispensable,...we wish to exclude especially...the view that metaphysical agents must be found before a fact can be adequately explained.**” (679)

¹ Recall **Lecture I**: Such a philosophical branch distinguished sharply contexts of *discovery/justification* (H. Reichenbach) and focused on *final products of science* (usually ‘textbook-ready’ theories) as proper object of philosophical scrutiny. Members included Carl Hempel, Herbert Feigl, Rudolf Carnap, Hans Reichenbach, and Karl Popper in his early years. Ludwig Wittgenstein also (in his pre-war-WWI- years associated himself with the Circle)

² Recall **Lecture II**: First Order Predicate Logic.

³ Recall **Lecture II**: Propositions refer to concepts representing some state of affairs which can be characterized by truth-evaluable statements.

Hans Driesch's (biologist). Theory of regeneration accounted for by "entelechies."

"Driesch said, in effect, 'The entelechy is a certain specific force that causes living things to behave in the way that they do. But you must not think of it as a *physical* force such as gravity or magnetism. Oh no, nothing like that.'" (680)

Analogy with physics: *Energy*, and its non-locality ("[entelechies] act on the entire organism, not just certain parts of it.") analogous to *effects attributed to potentials* (like the Aharanov-Bohm effect in quantum physics.⁴)

- **However (argues Carnap):** If one presses a physicist further, the physicist's explanation will involve laws (whether quantitative or qualitative). "[Q]ualitative laws can be expressed in the 'if...then...' form. **The point I wish to express here is this: it is not sufficient, for the purposes of explanation, simply to introduce a new agent by giving it new name. You must also give laws.**" (681)
- **Driesch simply doesn't:** "He did not specify how the entelechy of an oak tree differs from the entelechy of a goat or giraffe...He merely classified organisms and said that each organism has its own entelechy." (ibid) "Since the notion of entelechy does not give us new laws, it does not explain more than the general laws already available. It does not help us in the least in making new predictions. For these reasons we cannot say our scientific knowledge has increased." (682)

Explanation \Leftrightarrow Prediction

1.) (Law: Whether universal or statistical) $\forall x: Px \rightarrow Qx$

2.) Instance: Pa

$\therefore Qa$

- If a prediction, Qa is simply a fact not yet known. (682)
- Recall Glymour (problem of past evidence) Carnap extends notion of prediction to include cases of *retrodiction* (in the case of a historian making explanations). "[W]e have the same logical schema and the same knowledge situation—a known fact and a known law from which an unknown fact is derived." (683)

⁴ A demonstration of a truly dynamically non-local effect: a charged particle propagates through a *solenoid* which shields it from the *local* electromagnetic force interaction. Nevertheless, the *non-local* effect of the force's *vector potential* affects the particle, insofar as it having an influence on the particle's *phase* (part of what comprises a particle's *state vector*, which expanded in a position basis, becomes its *wavefunction*.)

Carl Hempel:

“Two Basic Types of Explanation”

- **Explananda can be subdivided into classes of particular facts and uniformities expressed by general laws. (685)** (Example: soap bubbles/gas laws \Leftrightarrow heat exchange principles.)

“Science raises the question ‘why?’ also with respect to uniformities expressed by...laws, and often answers [such questions] in basically the same manner...by subsuming the laws under more inclusive laws, and eventually under comprehensive theories.⁵” (686)

The D-N (Deductive Nomological) or ‘Covering’ Model:

$$\frac{\begin{array}{l} 1. C_1, C_2, \dots, C_n \\ 2. L_1, L_2, \dots, L_m \end{array}}{E}$$

C_1, C_2, \dots, C_n : statements describing particular facts

L_1, L_2, \dots, L_m : statements describing general laws

E : The explanandum

Causal Explanations are D-N (but the converse doesn’t hold) (687)

L_1, L_2, \dots, L_m : statements describing general laws are strictly universal, though there are instances when laws are statistical. **(I-S: Inductive statistical model)**

Example (Notes from Hawthorne)

1. S is a **random sample** of C (crows).
2. $|S| = n$ (i.e. S has n members)
3. The **frequency** (or proportion) of members of C having property B (i.e., being black) in sample S is $r (= 1)$. (I.e. $f[B, C \cap S] = r = 1$)

-----[p]⁶

\therefore [To a **margin of error** q conclude that] The **proportion** of **all** members of C having property B is $r (= 1)$.

⁵ As Kuhn and Lakatos have made clear, this schema can be problematic. For instance: Newton’s laws don’t ‘really’ ‘explain’ Kepler’s. (One needs auxiliary conditions like perturbation theory) - Lakatos

⁶ Note: the ===[p] notation means: “Conclude with degree of support p .”

“The likelihood referred to in [p] may be characterized as the strength in inductive support, or the degree of rational credibility, in which the explanans confers upon the explanandum.” (689)

Analogy of I-S/ D-N models with metamathematical proof-theory: they serve as *explication devices*, i.e. are rational reconstructions of models of explanation (therefore both descriptive and normative). (691)

- **Recall remark (Lecture XVII) regarding the Quine-Duhem Indeterminacy. “We might want to regard a particular event as completely explained only if an explanatory account of deductive and inductive has been provided for all its aspects. This notion, however, is self-defeating, for any particular event may be regarded as having infinitely many different aspects or characteristics, which cannot all be accounted for by a finite set, no matter how large.” (693)**