

# Explanation: D-N model (and I-S model)

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## Explanation as purpose of science

- some believe that science must deliver **explanation** of why something happens—over and above **description** of what happens or **prediction** of what will happen
- assume we have a theory
- problem of explanation may not be independent from problem of **evidence** (What is it to have evidence to believe in a theory?)
- **explanatory inference**: inference from set of data to hypothesis that would **explain** data
- logical empiricism: covering-law model of explanation (did we see this before?)

# Hempel and Oppenheim 1948



- Carl G Hempel (1905-1997), my academic grandfather
- *explanandum*: that which is to be explained
- *explanans*: that which explains
- “By the explanandum, we understand the sentence describing the phenomenon to be explained (not that phenomenon itself); by the explanans, the class of those sentences which are adduced to account for the phenomenon.” (p. 152)
- explain = show how to derive by logical argument
- premises (= explanans), conclusion (= explanandum)

## D-N (“deductive-nomological”) model of explanation

“nomos” = (Greek) law

(1)  $L_1, \dots, L_n$  (*general laws of nature*)

(2)  $C_1, \dots, C_m$  (*particular facts*)

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(3)  $E$  (*explanandum*)

⇒ not much difference between explanation and prediction!

## Conditions of adequacy

An argument of the form of the H-O scheme qualifies as scientific explanation if (among others) the following conditions are satisfied:

- 1 The explanandum follows deductively from the propositions in the explanans.
- 2 All propositions of the explanans are true.
- 3 The explanans contains at least one proposition expressing a general law of nature.
- 4 The explanandum does not follow from the non-nomological (= non-lawful) propositions of the explanans alone.
- 5 The laws in the explanans are not only true, but also in fact laws of nature according to our best science.

The first two conditions can be seen as the “deductive” part, and conditions 3 through 5 as the “nomological” part of the explanation.

## The role of laws

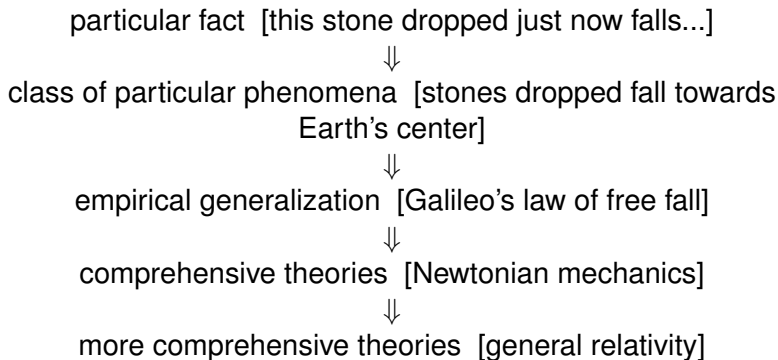
Obviously, laws do important explanatory work—but just what is a law?

- first pass: true generalization
  - need to distinguish those that are accidentally true from “laws”
  - example of accidental truth: “All members of the Greensbury School Board for 1964 are bald”, “All fruits in the garden are apples”
  - example of law: “All gases expand when heated under constant pressure”
  - Hempel: “counterfactual support” is diagnostic of lawhood, but philosophically hard to capture
- ⇒ notion of law has proved “highly recalcitrant” (1965, p. 338)
- second pass: law = true, exceptionless generalization describing regularity PLUS some additional, yet unspecified conditions

# The dispensability of a general analysis of laws

- DN-model of explanation does not depend upon our ability to formulate a general account of laws of nature, so long as we can agree which statements qualify as laws
- ⇒ no criteria, condition, explication of lawhood required
- Important: **that** there is a law in the explanans, but not **why** the statement at stake is a law
- Problem: what to do in less clear cases, such as Mendel's law of segregation, which has exceptions
- Note: we are not allowed to infer from our intuition that a statement does explanatory work that it is a law, **that would be unjustifiedly circular**
- Problem: according to some philosophers (e.g. Woodward) many generalizations from special sciences may well do explanatory work, but not qualify as laws

## Hempel 1962: "Hierarchy of covering laws"



⇒ increase in **breadth** and **depth** of scientific understanding

**breadth**: new principles cover broader range of phenomena

**depth**: original empirical laws seen as holding only approximately or within certain limits

**Causal explanations** are deductive-nomological in character, but there are D-N explanations which aren't causal (e.g. subsumption of Kepler's laws under Newtonian mechanics, temporal order may be different)

$\{\text{Causal explanations}\} \subset \{\text{D-N explanations}\}$

## Difficulties of the D-N model

The difficulties come in two broad categories:

- D-N model is **not necessary**, i.e. there are sets of statements that clearly are explanations but do not qualify as explanations according to the D-N model  $\Rightarrow$  conditions are **too narrow**
- D-N model is **not sufficient**, i.e. there are sets of statements that qualify as explanations according to the D-N model yet one would not normally think of them as explanatory  $\Rightarrow$  conditions are **too broad**

# The D-N model as unnecessary

- 1 probabilistic explanations seem important in medicine, genetics, quantum mechanics, statistical physics... yet D-N model can't account for them
- 2 Michael Scriven (1962): statement "The impact of my knee on the desk caused the tipping over of the inkwell" should count as explanatory although it does not involve a law

## (1) Probabilistic explanation (I-S model)

**Probabilistic explanations:** not deductively valid argument as demanded by D-N model

⇒ **inductive-statistical explanations (I-S model)**

Two features:

- 1 laws of probabilistic-statistical form such as “Smoking leads to lung cancer”
- 2 inference is not deductively valid, only “inductive”

I-S model is natural extension of D-N model because of

- **nomic expectability:** a phenomenon is explained if it is shown that it is to be rationally expected, given the particular circumstances and the relevant laws
- **deflationist account of causation:** Humean regularity theory of causation

- (1)  $F_i$  (in case  $i$ , factors  $F$  were realized)
  - (2)  $p(O, F)$  is very high (law of probabilistic form)
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(3)  $O_i$  (instance  $i$  under consideration has outcome of type  $O$ )

Important: (1) and (2) make (3) *very likely* rather than deductively certain (indicated by double line)

likelihood: relation (capable of gradation) between statements—not kinds of occurrences as in the probabilistic law; “strength of inductive support”, “degree of rational credibility”

## (2) Self-admitted limitation of D-N model

- formulation may be *incomplete* or *elliptic* (omit mention of certain laws or facts), but gaps can readily be filled in
- *partial explanation*: complete grounds for expecting that some event or other of a certain class will occur, but nothing about which one exactly
- actual explanation are always partial in this respect because particular event has *infinitely* many different aspects, not all of which can be accounted for by *finite* set of explanatory statements
- *explanation sketch*: even more cursory

# Scriven's example reconstructed

(from Woodward, 2003, Section 2.4)

- 1 “Whenever knees impact tables on which an inkwell sits and further conditions  $K$  are met (where  $K$  specifies that the impact is sufficiently forceful, etc.), the inkwell will tip over. (Reference to  $K$  is necessary since the impact of knees on table with inkwells does not always result in tipping.)
  - 2 “My knee impacted a tables on which an inkwell sits and further conditions  $K$  are met.
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- 3 “The inkwell tips over.”

## The D-N model as insufficient: causation

If explanans and explanandum don't stand in the relevant causal relation, insufficiency worries arise:

- 1 **Retrodiction**: position of planet today and the laws of celestial mechanics don't *explain* the planet's position yesterday
  - 2 **Common cause**: the falling barometer and the laws of meteorology don't explain the incoming low-pressure front; neither do the yellow fingers and the "laws of medicine" explain the lung cancer
  - 3 **Asymmetry** (Sylvain Bromberger 1966): case of flagpole and shadow
- General: Problems concerning causal relations point to possibility that explanation and prediction may not be on a par
  - Hempel's reply: if D-N model allows explanations to run in two directions, both directions must really be OK

## The D-N model as insufficient: irrelevance

**Irrelevance** (Wesley Salmon, 1971):

*(1) All males who take birth control pills regularly fail to get pregnant.*

*(2) John Jones is a male who has been taking birth control pills regularly.*

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*(3) John Jones fails to get pregnant.*

These arguments indicate that we may need additional conditions, i.e. that the D-N model only offers necessary, but insufficient conditions.

Next week: **Kitcher and unification**