Scientific Explanation, day 2

Review

- According to the *deductive-nomological* model of explanation, an explanation is a deductively valid argument whose premises are the explanans and whose conclusion is the explanandum.

$$
\left.\begin{array}{c} C_1, C_2, ..., C_N \\ L_1, L_2, ..., L_M \end{array}\right\} \textit{Explanans}
$$
$$
\frac{}{E} \quad \Big\} \textit{ Explanandum} \tag{DN}
$$

  In order for a DN-argument to be adequate, it must contain at least one law statement which is necessary for the argument to be valid (without the law statement, the argument is *invalid*), and the explanans must all be both true and have *empirical content* (that is, they must be testable).

- We saw many problem cases for the DN account.
  - the birth control explanation
  - the ink stain explanation
  - the flagpole-shadow explanation

  Salmon suggests that each of these problem cases points us towards a new theory of scientific explanation: in order to have a good scientific explanation, it is necessary that the explanans include *causes* of the explanandum.

  - We can explain an effect in terms of its cause. We cannot explain a cause in terms of its effect.

Inductive-Statistical Model of Explanation

- In the *inductive statistical* model of explanation, Hempel (and Oppenheim) attempt to extend the *deductive nomological* account to cover cases involving *statistical* explanations of phenomena.
  - There are many cases in which science explains phenomena through appeal to *probabilities*
    * Explanation of why a mutation does or does not becomes common in a species in evolutionary biology. (The mutation makes is *more likely* that the creatures who possess it will reproduce.)

- Explanation of why a person contracted lung cancer or mesothelioma (the smoking or the asbestos made it *more likely* that they would).

- As the deductive nomological model claimed that we could explain phenomena by subsuming them under *laws*—that is, exceptionless regularities—the IS model claims that we can explain phenomena by subsuming them under *probabilities*.
- It says that a statistical explanation of E is an inductive argument which contains some matters of particular fact $C_1, C_2, ..., C_N$ and a probabilistic statement to the effect that the probability of the explanandum E given the (other) explanans $C_1, C_2, ..., C_N$ is some high number x.

$$\begin{array}{c} C_1, C_2, ..., C_N \\ P(E \mid C_1, C_2, ..., C_N) = x \\ \hline\hline E \end{array} \tag{IS}$$

A Problem

- The move to inductive arguments opens up a problem: while deductive arguments are *monotonic*, or *erosion-proof*, inductive arguments are *non-monotonic*, or *not erosion-proof*.
  - That is, *adding premises* to a deductively valid argument will not make the argument deductively invalid.
  - However, *adding premises* to an inductively strong argument can make it inductively weak.
- Consider this pair of examples:

$$\begin{array}{l} \text{1. Jane has a streptococcus infection.} \\ \text{2. Jane was treated with penicillin.} \\ \text{3. } P(\text{ Jane recovered} \mid 1 \wedge 2) = 0.9. \\ \hline\hline \text{4. Jane recovered.} \end{array}$$

$$\begin{array}{ll} 1. & \text{Jane has a streptococcus infection.} \\ 2. & \text{Jane was treated with penicillin.} \\ 3. & \text{Jane's steptococcus infection is a} \\ & \text{rare penicillin-resistent variety.} \\ 4. & P(\text{ Jane recovered} \mid 1 \wedge 2 \wedge 3\ ) = 0.01. \\ \hline\hline 5. & \text{Jane recovered.} \end{array}$$

- By just *adding the extra premise* 3, we transformed a very strong inductive argument into an incredibly weak one.
- We can understand this in Bayesian terms, since $P(A \mid B)$ can be as high as we like (shy of 1) and yet $P(A \mid B \wedge C)$ can be zero. [On your next problem set, you'll be asked to provide an example like this.]

- So, Hempel and Oppenheim require that the inductive statistical argument satisfy the *requirement of maximal specificity*, which requires that we include all *relevant* knowledge which would have been available prior to the explanandum event.

Problems with the Inductive Statistical Model

- If the probability of E is already high, then conditionalizing on causally and explanatorily irrelevant factors will leave it high.

$$\begin{array}{ll} 1. & \text{John contracted a cold on Monday.} \\ 2. & \text{John took vitamin C on Monday.} \\ 4. & P(\text{ John recovers by Wednesday} \mid 1 \wedge 2\ ) = 0.9. \\ \hline\hline 5. & \text{Jane recovers by Wednesday.} \end{array}$$

  - Given the correctness of this inductive argument, the vitamin C *might* explain John's recovering by Wednesday, but it *might not*.
  - If, for instance, $P($ John recovers by Wednesday $\mid 1) = 0.9$, then it doesn't look like John's taking vitamin C does much to explain the recovery.

- The explanans need not make the explanandum highly probable.
  - For instance, paresis is a form a tertiary syphilis which is only contracted by people who go through the primary and secondary stages of syphilis without treatment. However, only about 25% of people who have untreated primary and secondary syphilis end up contracting paresis. Yet the untreated primary and secondary syphilis *do* explain the paresis, though they don't make it more probable than not.
  - Indeterministic Weed Killer: The chancy weed killer doesn't make it very probable that the weed dies. But still, if the weed *does* happen to die, it is the indeterministic weed killer that did it.

Salmon's Statistical Relevance Model of Explanation

- In order to solve both of these problems, Salmon suggests that we need to revise the IS model to take account of not merely the *value* of the probability $P(E \mid C_1, C_2, ..., C_N)$, but additionally the ways in which conditionalizing upon $C_1, C_2, ..., C_N$ *changes* the probability of E.
- Some terminology: if

$$P(A) = P(A \mid B)$$

  then B is *statistically irrelevant* to A. If

$$P(A) > P(A \mid B)$$

  then B is *positively statistically relevant* to A. If

$$P(A) < P(A \mid B)$$

  then B is *negatively statistically relevant* to A.

- Providing a list of factors which are *statistically relevant* to the explanandum (along with a list of the associated probabilities) constitutes an adequate explanation.

Looking Forward: Causation and Probability

- The account does not clearly distinguish probabilistic correlation from *causation*. And these two can come apart in a variety of ways.
  - Causation is *asymmetric*. Correlation is *symmetric*. [You proved this on your problem sets] So, if causes raise the probability of their effects, then effects have to raise the probability of their causes.
  - Effects of a common cause can be correlated, even though they are not causally related.
- In both of these cases, it appears that the non-causal correlations provide poor explanations of their explanandum.
  - The barometer *forecasts*, but doesn't *explain* the storm.
  - paresis raises the probability of syphilis (to 1), but doesn't explain it.

Friedman, Kitcher, and Cartwright's 'Pattern Subsumption' Model of Explanation

- Some philosophers (Friedman and Kitcher, in particular) have thought that what an explanation does is integrate the explanandum into a larger pattern. It *unifies* the explanandum phenomenon with other, disparate kinds of phenomena.
- On this view, an explanation subsumes a phenomena under a larger pattern.
- Not just any pattern will do. The pattern must subsume *many* disparate phenomena. The patterns that do this are better fit to explain than those which only subsume a small number of phenomena.

Looking Back: Laws and Explanation

- The explanation objection to Lewis's *Best Systems Account*.
- The laws get to *explain* things; but mere regularities do *not* get to explain things.
  - That the rock is in a box which only contains granite rocks does not explain *why* the rock is granite.
  - Similarly, that a pair of electrons is in a universe which contains only pairs of electrons which repel one another does not explain *why* the pair of electrons repel one another. But the *law* that electrons repel one another *does* explain it.
  - So, the objection goes, regularities (even highly informative ones) don't explain. But laws do explain, so laws can't be regularities.
- The Best Systems theorist can appeal to the *Pattern Subsumption* model of explanation to make sense of laws' ability to explain.