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.

\[
\begin{align*}
C_1, C_2, \ldots, C_N \\
L_1, L_2, \ldots, L_M
\end{align*}
\]  
\( \{ \text{Explanans} \)  
\[ E \]  
\( \{ \text{Explanandum} \)  

(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 it 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 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 $x$.

$$C_1, C_2, ..., C_N
\begin{equation}
P(E \mid C_1, C_2, ..., C_N) = x
\end{equation}
E$$

### 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:

  1. Jane has a streptococcus infection.
  2. Jane was treated with penicillin.
  3. $P(\text{Jane recovered} \mid 1 \land 2) = 0.9$.

  1. Jane has a streptococcus infection.
  2. Jane was treated with penicillin.
  3. Jane’s streptococcus infection is a rare penicillin-resistant variety.
  4. $P(\text{Jane recovered} \mid 1 \land 2 \land 3) = 0.01$.
  5. Jane recovered.

- 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 $P(A \mid B \land C)$ 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.

1. John contracted a cold on Monday.
2. John took vitamin C on Monday.
4. $P(\text{John recovers by Wednesday} \mid 1 \land 2) = 0.9$.
5. Jane recovers by Wednesday.

- Given the correctness of this inductive argument, the vitamin C might explain John’s recovering by Wednesday, but it might not.
- If, for instance, $P(\text{John recovers by Wednesday} \mid 1) = 0.9$, 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.