Phil/LPS 31 Introduction to Inductive Logic
Lecture 18

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Topics

- Causal Inference
- Observational Studies (No intervention)
  - Case-control studies: Retrospective Studies
  - Cohort studies: Prospective Studies
- Experimental Studies (Intervention)
  - Randomized Control Studies
- Relative Risk
- Odds Ratio
- Simpson's Paradox
- Internal and External Validity of Studies

Hume and Causal Inference

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- The answer he wanted was that the only empirical justification was custom and habit. But before he could say that this was the only empirical justification, he had to show that no other non-empirical justification was possible!

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- But what does modern science have to say about causation (bracketing the issue of the metaphysics and the rational justification of causal inference as a form of inductive inference)?
- Let us spend the next two lectures discussing that.

Two kinds of studies in science

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- We shall see more distinguishing features of these two major kinds of studies when we look at each more closely below, starting with observational studies.

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- For each of these kinds of observational studies, I want you to know: (1) what it is; (2) what are the key measures looked for by scientists; (3) what are the advantages and drawbacks of each kind of study.

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- Researchers select subjects at the onset of the study and then determine whether they have the risk factor or have been exposed.
- All subjects are then followed over a certain period to observe the effect of the risk factor or exposure. Because the events of interest transpire after the study is begun, these studies are sometimes called prospective studies.

An Example of a Cohort Study

- The Framingham Study, began in 1948, followed up a sample of 5,209 men and women residing in Framingham, Mass. with the use of clinical examinations, conducted every 2 years, and continuous surveillance of morbidity and mortality. On each examination a variety of characteristics were measured, including blood chemistry values and blood pressure; an electrocardiogram is taken; and a thorough cardiovascular evaluation is made after obtaining a routine history and physical examination.

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- Their results showed that persons at high risk of cardiovascular disease can be effectively identified from a measurement of their serum cholesterol and blood pressure, a smoking history, an electrocardiogram and a determination of glucose intolerance.

Advantages and Draw-backs of Cohort Studies

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- The cases in case–control studies are individuals selected on the basis of some disease or outcome; the controls are individuals without the disease or outcome.
- The history of both cases and controls are analyzed in an attempt to identify a characteristic or risk factor present in the cases' histories but absent the controls' histories.

An Example of a Case-Control Study

Margaret A. Olsen and colleagues (2003) studied data obtained in patients between 1996 and 1999 who had undergone laminectomy or spinal fusion. Forty-one patients with surgical site infections (SSI) or meningitis were identified, and data were compared with those acquired in 178 uninfected control patients. For patients with SSI the postoperative hospital length of stay was significantly longer than that in uninfected patients. The study concluded that postoperative incontinence, posterior approach, surgery for tumor resection, and morbid obesity were independent risk factors predictive of SSI following spinal surgery. Interventions to reduce the risk for these potentially devastating infections need to be developed.

Advantages and Draw-backs of Case-Control Studies

Experimental Studies: Basic Ideas

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- The second fundamental feature of an experiment is that the researcher exerts control over, or minimizes the variability in, variables other than the independent and dependent variable.

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- The manipulation of an independent variable must involve the active intervention of the researcher. Comparing groups of people who differ on the independent variable before the study begins is not the same as manipulating that variable.
- The active manipulation of the independent variable is crucial for eliminating potential alternative explanations for the results.

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- However, sometimes greater insights can be gained by adding more conditions to an experiment. When an experiment has one independent variable that is manipulated to produce more than two conditions it is referred to as a single factor multi-level design.

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- Extraneous variables make it difficult to detect the effect of the independent variable in two ways. One is by adding variability or "noise" to the data (in a non-systematic way across different levels of the independent variable) The other way is by confounding (which is systematic variation, on average, across the different levels of the independent variable due to that extraneous variable)

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- To confound means to confuse, and this effect is exactly why confounding variables are undesirable. Because they differ systematically across conditions – just like the independent variable – they provide an alternative (causal) explanation for any observed difference in the dependent variable. See Simpson's Paradox later.

Experimental Studies: Control

- For example, in almost all experiments, participants' intelligence quotients (IQs) will be an extraneous variable. But as long as there are participants with lower and higher IQs in each condition so that the average IQ is roughly equal across the conditions, then this variation is probably acceptable (and may even be desirable). This is "noise".

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- What would be bad, however, would be for participants in one condition to have substantially lower IQs on average and participants in another condition to have substantially higher IQs on average. In this case, IQ would be a confounding variable.

Experimental Studies: Randomized Control Studies

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- But this approach is not always desirable because of potential bias. A second and much more general approach is random assignment to conditions.
- This is the basis of randomized control studies.

Experimental Studies: Randomized Control Studies

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- In medicine, randomized control experiments that involve humans are called randomized clinical trials because their purpose is to draw conclusions about a particular procedure or treatment.
- If participants in the treatment arm end up better off than participants in the control arm, then the researcher can conclude that the treatment is effective.

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- To reduce the chances that subjects or investigators see what they expect to see, researchers can design double-blind trials in which neither subjects nor investigators know whether the subject is in the treatment or the control group. When only the subject is unaware, the study is called a blind trial.

An Example of a Randomized Control Study

The Physicians' Health Study (Steering Committee of the Physicians' Health Study Research Group, 1989), which investigated the role of aspirin in reducing the risk of cardiovascular disease. One purpose was to learn whether aspirin in low doses reduces the mortality rate from cardiovascular disease. Participants in this clinical trial were over 22,000 healthy male physicians who were randomly assigned to receive aspirin or placebo and were followed over an average period of 60 months. The investigators found that fewer physicians in the aspirin group experienced a myocardial infarction during the course of the study than did physicians in the group receiving placebo.

Advantages and Draw-backs of Randomized Control Studies

Internal vs. External Validity of Studies

Measures of Association in 2×2 contingency tables

Relative Risk

Odds Ratio

Simpson's Paradox