PLS 506
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Lecture Notes:
Program Theory

Scientific vs. nonscientific questions

- Scientific is subject to verifiable observations
- Transscience – uses the language of science but question can't be answered scientifically – some political or value judgments must be made
- To qualify as scientific knowledge, the answers to the questions must meet the requirements of description, explanation, prediction, and understanding

Scientific process

- Theories
- Predictions (hypotheses)
- Observations
- Empirical generalizations

Key principles underlying scientific process

- Empiricism
- Objectivity
- Control

Elements of logical analysis

- Terms: It is whatever is meant by a word or phrase
- Meaning: a term is neither true or false. It is analogous to a concept in science. You can understand a term but cannot affirm or deny it
- Proposition: an expression of judgment about a term or terms. It is a declarative sentence.
  - It is either true or false.
  - Categorical (all/none) or conditional – joined by an if-then statement
  - Conditional proposition introduced by the if is the antecedent
  - Part that follows the then is the consequent
  - A conditional proposition asserts that the antecedent implies the consequent
  - Two if-then relationships.
    - Definitional – if it is a triangle then it has three sides.
    - Causal – if metal is immersed in nitric acid, then it dissolves
    - Scientists are primarily concerned with the causal conditional propositions
- Arguments string conditional propositions together
  - Constructing the arguments is the logicians way of making explicit a person's reasoning from evidence to conclusion
  - Premises precede the conclusion
    - All men are mortal (premise)
    - Socrates is a man (premise)
    - Therefore, Socrates is mortal (conclusion)

- Syllogism: arguments composed of three propositions – two premises and a conclusion
  - Longer arguments can always be broken down into syllogisms
  - Validity depends on the relations between premises and conclusions
  - You can have a valid syllogism based entirely on false statements
    - All students are seniors (F)
    - Some robots are students (F)
    - Therefore, some robots are seniors (F)
  - You can have an invalid syllogism based on true statements
    - All butterflies can fly (T)
    - All crows are birds (T)
    - Therefore, all crows can fly (T)
- Deduction and induction
  - Deductive reasoning: Claiming the conclusion must absolutely be true if all premises are true. It moves from general principles to particular instances.
  - Inductive reasoning: Claims that the conclusion is probably true but not necessarily true if all of the premises are true. It involves drawing conclusions that exceed the information contained in the premises. It moves from the particular to the general.
  - Deductive:
    - If Joan belongs to the union, then she votes democratic
    - Joan belongs to the union
    - Therefore, Joan votes democratic
  - Inductive:
    - Joan, Bob, and Fred are all union members and vote democratic
    - Therefore, all union members vote democratic
- Valid Argument forms
  - Affirming the antecedent
    - If *p*, then *q*
    - *p*
    - Therefore, *q*
  - Denying the consequent
    - If *p*, then *q*
    - Not *q*
    - Therefore, not *p*
  - Chain argument
    - If *p*, then *q*
    - If *q*, then *r*
    - Therefore, if *p*, then *r*
- Invalid argument forms
  - Fallacy of affirming the consequent
    - If *p*, then *q*
    - *q*
    - Therefore, *p*
  - Fallacy of denying the antecedent
    - If *p*, then *q*
    - Not *p*
    - Therefore, not *q*

- Some basic rules on argument forms
  - If all the premises are true and the argument is valid the conclusion must be true
  - If all of the premises are true and the conclusion is false, then the argument must be invalid
  - If the argument is valid and the conclusion is false, then at least one premise must be false
- Logic of hypothesis testing
  - Logical argument is as follows:
    - If the hypotheses is true, then the predicted fact is true
    - The predicted fact is false
    - Therefore, the hypotheses is false
- To reject the hypothesis we must assume that the prediction is clearly implied (valid deduction) and that the prediction is indeed false.
- To provide inductive support for a hypothesis we must assume that the prediction is clearly implied and that it is true.
- Scientists generally regard disconfirming evidence as a stronger basis for rejecting a hypothesis than confirming evidence provides for accepting a hypothesis
  - The argument for rejecting is based on a deductive argument
  - The argument for accepting is based on an inductive argument