Phil 2302 Intro to Logic

Introduction to Induction[i]

"The object of reasoning is to find out, from the consideration of what we already know, something else which we do not know. Consequently, reasoning is good if it be such as to give a true conclusion from true premises, and not otherwise. . . . We are doubtless, in the main, logical animals, but not perfectly so."
—Charles Sanders Peirce, "The Fixation of Belief"

I. Introduction to Induction

A. Deduction and induction compared

Not everything can be rationally or deductively proven. For example, how many people believe in UFOs, or how many people believe that abortion is wrong, or whether or not all swans are white, or what the likelihood is that life arose by accident are matters that no syllogism can tells us. These issues demand the consideration of numerous factors from which a conclusion may be legitimately drawn. This is called induction.

> Deduction reasons from general ideas to particular circumstances (all men are mortal = the general idea, to John is mortal = the particular circumstance).
>
> Induction reasons from particular instances to general conclusions (Socrates, Aristotle, Moses, Adam, Tom, Dick, Harry are all mortal = the particular instances to the general conclusion that "all men are mortal").

The biggest difference between deductive and inductive reasoning, however, has to do with certainty and probability:

> In deductive logic, the conclusions were either true or false and had to be that way. If you built a valid syllogism with true premises and no fallacies, then your conclusion must be true. The argument was wholly sound.
>
> In induction, we are not always sure if the propositions leading to a conclusion are always true or false, and so conclusions in inductive arguments are only probable. There are various degrees of probability ranging from virtual certainty to virtual impossibility, but you can never know any proposition with absolute certainty based on inductive logic.

One exception to this is what is called a **perfect induction** which is capable of controlling all possible factors leading to the conclusion. For example, if I stated, "All the coins in my right hand are pennies," you could examine my right hand, count the pennies and verify or falsify my inductive assertion.

The probable nature of inductions can be seen from the following example which shows how inductive arguments, proceeding by analogy, could lead to a false comparison.

A, B, C, and D all have qualities p and q.
A, B, and C all have quality r.
Therefore, D has quality r also.

This is reasonable as long as there is a connection between qualities p and q and r. But this connection is not necessary.

Sparrows, sea gulls, and hummingbirds
(A, B, C) have wings (p) and feathers (q) and are able to fly (r).
Canadian Honkers (D) have wings and feathers (p and q);
They, too, will probably be able to fly (r).

But what about penguins? They have wings (p) and feathers (q), but it cannot fly (r). Thus, the conclusion reached that D with p and q will normally lead to r is probably true, but not always necessarily, and in this last case, is not true. Inductions, then, are always probable. The following typology of inductive arguments will suggest this all the more.

B. A typology of inductive arguments

1. Inductive prediction: the premises deal with some known event in the present or past, and conclusion moves beyond this event to some event in the near future (weather patterns, prime interest rate, etc.)

2. Inductive analogy: an argument that depends on the existence of an analogy, or similarity, between two things or states of affairs. A certain condition that affects the better known thing or situation is concluded to affect the lesser known thing or situation. The illustration above about wings and feathers is a good example.

3. Inductive generalization: this is an argument that proceeds from a selected sample to some claim about the whole group (election polls).

4. Inductive argument from authority: an argument in which the conclusion rests upon a statement of some presumed authority or witness who has assimilated facts and reached a conclusion (lawyer, investment counselor, etc.).

5. Inductive argument based on signs: an argument that proceeds from the knowledge of a certain sign to a knowledge of the thing or situation that a sign symbolizes (highway signs, letters as signs forming words and how they are to be pronounced in other words)

6. Inductive causal inference: arguments that proceed from a knowledge of cause to effect (water left in freezer is now frozen; design to a designer) or from a knowledge of effect to the cause (design to designer, crispy chicken to the fact that it was overcooked).

In every one of these arguments, the content of the conclusion goes beyond what is contained in the premises, and there is some kind of uniform analogy between the premises and the conclusion reached.

II. The Nature of Probable Inductive Conclusions

A. Perfect inductions

Most inductive arguments, based as they are on analogies, extend observations of some sample to a whole class and consequently involves what could be called an **inductive leap**. However, when all the particulars are known, a perfection induction can be made. For example, how many computers are in the computer lab, how many fingers on my hand, how many dates I had last weekend.

B. Imperfect inductions (inductive leaps)

As mentioned above, inductions extend their findings to make broad, general statements or conclusions. These statements or conclusions cannot be said to be absolute or universally true because unknown exceptions are possible. Thus, rather than being true or false (as in deduction), inductions are more or less probable, involving degrees of probability, which can be measured as to their percentage of accuracy. Inductive conclusions should be evaluated in relation to the following scale:

Degrees of Probability:

99%±—Virtually Certain (gravity)

90%±—Highly Probable (no two snowflakes alike)

70%±—Probable (for medicines to be approved)

50%±—Possible (coin toss)

30%±—Improbable (life on other planets?)

10%±—Highly Improbable (that Jesus visited N. America)

1%±—Virtually Impossible
(Unicorns or Mermaids)

Now, there are at least two types of probabilities, statistical probabilities which employ mathematical formulas to determine their likelihood, and empirical probabilities which is based not on numbers but empirical data.

III. Statistical Probability:

A. Terms must be clearly defined

It does no good to compile a lot of date about things when the things you are asking about mean different things to different people. For example, if you are seeking information about political "liberals," the term "liberal" must be clearly specified. A religious survey asking: "Do you believe Jesus was the Son of God?" must involve a clear definition of what is meant by "Son of God."

B. Sufficient classes must be devised to cover all the data

The classes of Catholic, Protestant and Jewish are not sufficient to cover all the data on American religion. No longer, it seems, are the categories of Democrat and Republican sufficient to cover American politics. Nor is black and white to cover race issues

C. Only one principle of classification must be used.

This means that optional answers to questions must not be mixed in category else you have a category mistake. Answers must be either age, sex, race, political party, etc. but not a combination of several.

D. Classes must not overlap

If two answers are possible, some will answer both, some will answer only one, and some will not answer at all. These stats are worthless because you have no idea which answers give you the info you want or need.

E. The most appropriate method for reporting results must be selected.

1. Mean (average)

The average can be found by adding up all the figures and then dividing by the number of figures we added. The mean of 5, 6, 7, 8, & 9 is 7 (35 divided by 5 = 7). This shows where the group as a whole stands, like the average score on a test.

2. Mode (most frequent)

If you are interested, not in the average test score, but the score most people got, then you are in search of the class mode. It is found by simply discerning what number occurs the most often. If the test scores were 55, 66, 88, 88, 83, 88, 90, 93, 88, 88, 75, etc., then the mode would be 88. Technically, when we speak of the average man on the street, we really probably mean the modal man, the one we are most likely to run into.

3. Median (halfway between lowest and highest)

The median of the group is the number that occurs halfway between the highest and the lowest number in our data, or in a series consisting of an even number of numbers, a number midway between the two middle numbers. The median of 5, 6, 7, 8, and 9 is 7, the same as the mean number. The median of the series 2, 4, 8, 12, 16, 43 is 10, midway between 8 and 12. The median of 1, 2, 3, 50 is 2. 5. Often the median will be close to the mean, but not in cases where one piece of data is much higher or lower than the other numbers.

IV. Empirical Probability

A. How many cases were examined? How broad is the sample? 20% of the people or 80%? The more cases studied, the better the probability that the conclusion is true.

B. How representative is the evidence? How much like the real world was the testing environment? Did all the people surveyed work in the same office, or come from the same race, socio-economic bracket, political beliefs, etc.? The more differences there are between classes, the stronger the conclusion. If the cases studied don't reflect the real world, then how can the conclusion?

C. How carefully was the evidence examined? How many qualities of similarity and difference were studied? Were all possible explanations accounted for? Were the affected results isolated from other causes? Was all the evidence presented? How critically was the evidence evaluated?

D. How does the information gained relate to the body of knowledge we already have in general? Does it contradict anything we are sure of? Does it help explain things better? New evidence, with new explanatory power of the phenomena, is a welcomed discovery. We would possibly be on the verge of a paradigm shift. For example, the shifts from Aristotelian physics, to Newtonian, to Einsteinian; the shift from the geocentric universe to a heliocentric (thanks to Galileo!); the shift from one hermeneutical system to another that is better able to explain the Bible.

V. Kinds of Certainty

A. Mathematical certainty: (2 + 2 = 4; true by definition-one apple plus one apple equals two apples, by definition)

B. Logical certainty: (no contradictions are true; tautologies where the subject defines the predicate, e.g., all circles are round; triangles have three sides)

C. Existential certainty: (e.g., I exist; St. Augustine: doubt reveals the doubter; Descartes: "I think, therefore, I am")

D. Empirical certainty: (here we are in class with tables, chairs, marker board, handouts, etc)

E. Inductive certainty

1. Perfect inductions

2. Imperfect inductions (inductive leaps, but how great a leap is it)

F. Moral and spiritual certainty: (based on inner moral motions, conscience, natural law, divine revelation, categorical imperative)

"For I wished to be as assured of the things I saw not

as I was that seven and three are ten."
St. Augustine, *Confessions*, VI. 6. 6

VI. Some Interesting Mathematical Probabilities

A. Fred Hoyle, *Evolution from Space*: when all possible combinations are taken into consideration, the chances that the first living cell could arise accidentally are about 1 in $10^{40,000}$.

B. Hugh Ross: odds for the simplest life form to have occurred by pure chance would require a minimum of 239 protein molecules. Each of these protein molecules is composed of approximately 445 amino acids linked together. Each of these links must be made by a particular one of twenty different amino acids. So the chance that even the simplest life form coming together by random chance is 1 in $20^{445 \times 239} \div 239$ or 1 in $10^{137,915}$.

C. Even if it is highly unlikely that life arose by chance, there wouldn't even be enough time for it to happen (13-20 billion years). Suppose the universe was made entirely of amino acids (which is not so). There would be 10^{77} molecules to work with. If we linked all these amino acids together at random at a rate of about one per second for 20 billion years, then the chances of simple life form appearing is 1 in $10^{14,999,999,905}$. That's almost one in ten to the fifteenth billion power. Twenty billion years would not be long enough even if the universe were packed with the building blocks to produce life.

D. There are at least 48 key prophecies about the first coming of Christ. The odds that these prophecies could be fulfilled in one man is a bout 1 in 10^{157}.

[i] NB: This material is taken from several logic texts authored by N. Geisler, H. Kahane, and others. I make not claim to originality in this material.