INDUCTION

Conceptual Analysis

Induction is a specific form of reasoning in which the premises of an argument supports a conclusion, but does not ensure it. The topic of induction is important in analytic philosophy for several reasons and is discussed in several philosophical subfields including logic, epistemology and philosophy of science. However, the most important philosophical interest in induction lies in the problem concerning the justifiability of induction. This problem is often called "the problem of induction" and was discovered by the Scottish Philosopher – David Hume (1711 – 1776).

Inductive reasoning (induction) is the procedure of reasoning in which we take a particular fact towards common conclusion, but it does give guarantee that the grounds of intellectual argument hold the truth or correction of a conclusion. Through inductive conclusion, a single statement can be converted into large amounts of general theories or statements which mean that inductive reasoning is the process which leads specific statements into more general form. Induction is based on individual occurrences and on these bases, those occurrences or things are generalized in higher range. To simplify this, we can make our example supposing we know and have seen seminarians studying at Bigard Memorial Seminary; we can conclude that all seminarians study at Bigard Memorial Seminary. But, this position cannot be justified because there are many other seminaries both within Nigeria and beyond where seminarians study.

Inductive reasoning is criticized by many philosophers such as David Miller, Karl Popper and David Hume. These philosophers have controversial debate on induction and some of them even reject its state of being entirely.

Types of Inductive Reasoning

1. **Enumerative Induction:** This is induction in the real sense of the word. It is the kind of induction that philosophers are interested in. Enumerative induction comes in two forms – strong induction and weak induction. Here, induction is classified according to the strength of its output. Strong induction has the following form;

   A_1 is a B_1
   A_2 is a B_2
   A_3 is a B_3
   Therefore all A_s are B_s

   An example of strong induction is that all ravens are black because each raven that has been observed has been black. In other words, since each observed raven is black, all ravens are black. Notice that in strong induction, the morality or nature of the assumptions can make us sure or clear that the conclusions will be based on truth, but still there is no guarantee that it will be 100% correct. Consider the earlier example that seminarians are observed to study at Bigard. But, this position is doubtful or unclear – uncertain because, once we find a single seminarian that studies outside Bigard, the foundation of that argument crumbles.

However, notice that one needs not make such a strong inference with induction because of the tendency of such to fail at the first test. This is what the other type of induction known as weak induction brings to us. Weak induction has the following form:

A_1 is a B_1

A_2 is a B_2

A_n is a B_n

Therefore, the next A will be a B.

An example of a weak induction is that because every raven that has ever been observed has been black, the next observed raven will be black. Notice that the tendency to over generalize conclusions drawn from particular instances is minimized.

Mathematical Induction

Enumerative induction should not be confused with mathematical induction. When enumerative induction concerns matters of empirical facts, mathematical induction concerns matters of mathematical facts. Specifically, mathematical induction is what mathematicians use to make claims about an *infinite set* of mathematical objects.

Mathematical induction is different from enumerative induction because it guarantees the truth of its conclusions since it rests on what is called an "inductive definition" (sometimes called a "recursive definition"). Inductive definitions define sets (usually infinite sets) of mathematical objects. They consist of a ***base clause*** specifying the basic element of the set, one or more ***inductive clauses*** specifying the additional elements as generated from existing elements and the ***final clause*** stipulating that all of the elements in the set are either basic or in the set because of one or more applications of the inductive clause or clauses. For example: A is the set of 2, 4, 6. 8, 10, 12, 14, 16. This written mathematically appears thus:

$$A = \{2, 4, 6, 8, 10, 12, 14, 16\}$$

The above immediately indicates to one that A is a set which contains even numbers and the members of the set are infinite even though only eight numbers are listed in the set. Thus, every even number ad infinitum falls within the set 'A'. This is why we say that mathematical set unlike enumerative set guarantees the truth of its conclusion. In the above sample, set A, the base clause is 2, the inductive clause(s) are the other members of the set generated from 2 such as 4, 6, 8, etc; while the final clause is 16 but, notice that from 16, we can also infer the subsequent members of the set. Notice, that mathematical induction are both infallible and infinite because it rests on the inductive definition unlike enumerative induction which does not. *Inductive definition defines the nature of the set, its membership and the way subsequent members of the set must be derived.*

Non-inductive Reasoning

Induction contrasts with two other important forms of reasoning- deduction and abduction.

Deduction

Deduction is a form of reasoning whereby the premises of the argument guarantee the conclusion. Or more precisely, in a deductive argument, if the premises are true, then the conclusion is true. There are several forms of deductive reasoning (deduction) but the most basic one is *modus ponens*. Modus ponens takes the following format:

If A, then B

A,

Therefore B

Deductions are unique because they guarantee the truth of their conclusions if the premises are true. In this sense, deduction shares some affiliation with mathematical induction. Consider the following example of deductive argument:

Either Chucks runs track or he plays tennis
Chucks does not play tennis
Therefore, chucks runs track.

Notice from the conclusion of this argument that there is no way the conclusion can be false because the premises are true. Thus, the veracity of the conclusion of an ideal deductive argument is already and always contained in the premise(s) that help(s) to draw the conclusion. This is not the case however with inductive reasoning. Take the following example:

Every raven that has ever been observed has been black
Therefore, all ravens are black.

The above example is a typical inductive mode of reasoning. This manner of reasoning (induction) is deductively invalid because its premises can be true while its conclusion is false. For instance, some ravens could be brown although no one has seen them yet. Thus a feature of induction is that they are deductively invalid.

Differences Between Induction and Deduction

In Logic, induction and deduction are prominent methods of reasoning. Sometimes, people use induction as a substitute for deduction and erroneously make false and inaccurate statements.

Deduction uses more general information to arrive at a specific conclusion. It can be viewed as a pattern of reasoning wherein the conclusion is considered as the logical following of the premise or argument. The validity of the conclusion is based on the validity of the premise or argument. The conclusion strongly depends on the premises or the arguments in a deductive reasoning. Consider the following examples of deductive reasoning:

(1) The solar system has 8 planets.
Earth is one of the planets in the solar system.
Therefore, Earth is one of the eight planets.

(2) Party 'A' won the election
Mr X was the candidate for party 'A'
Therefore, Mr X will get the office.

Induction is a process where individual arguments and premises are used to develop a generalization or a conclusion that can be attributed to much more than the initial subjects. In this method, the conclusion may be validated or disproved by the preceding premises. Consider the following examples:

All the rivers I crossed flow toward the ocean

Therefore, all the rivers are flowing toward the ocean.

The above induction is true for all rivers because every river naturally flows into the ocean. But notice the movement from particulars to general. Consider this example also:

Month of August has experienced drought for the last 10 years.

Therefore, there will be drought conditions here for every August in Future.

This conclusion is not certain; it is probabilistic; it may hold true or may not. Most traditionally inductive reasoning follow this standard and hence suffer from the same lack.

Summarily, the following points demarcate deduction from induction:

1. Deduction is a form of logic that achieves a specific conclusion from the general, drawing necessary conclusions from the premise. Induction is a form of logic that

achieves general results from specific cases, drawing probable conclusions from the premises.

2. In deduction, the conclusion is accepted as the logical result of the premises, while in induction, the conclusion is formed from individual premises which may support it but does not make it true.

3. In deduction, the premises both support and confirm the truthfulness of the conclusion but in induction, the premises may support the conclusion but it rarely confirms it.

4. Deduction concludes with necessity while induction concludes with probability.

ABDUCTION

Abduction is a form of reasoning whereby an antecedent is inferred from its consequent; a cause is inferred from its effect. The form of abduction is below:

If A, then B
B,
Therefore, A

Notice immediately that abduction is a form of reasoning that is totally different from both induction and deduction. Abductive reasoning usually starts with an incomplete set of observations and proceeds to the likeliest possible explanation for the group of observation. It is based on making and testing hypothesis using the best information available. *It often entails making an educated guess after observing a phenomenon. For which there is no clear explanation.* For example, a person walks into their living room and finds torn up papers all over the floor. The person's dog has been alone in the room all day. The person concludes that the dog tore up the papers because it is the most likely scenario. Note, a rat may have been the culprit or some other factor; but the 'dog theory' is the most likely conclusion.

Notice that abductive reasoning is deductively invalid just like inductive reasoning because the truth of the premises in an abductive argument does not guarantee the truth of their conclusions. For example, *though all dogs have legs, seeing legs does not imply that they belong to a dog.* Abduction is different from induction, even though, both are used amply in everyday affairs as well as in scientific reasoning.

Note: *While both forms of reasoning do not guarantee the truth of their conclusions, scientists since Isaac Newton (1643 – 1727) have believed that induction is a stronger form of reasoning than abduction.*

Abductive reasoning is useful for forming hypotheses to be tested. Abductive reasoning is often used by doctors who make a diagnosis based on test results and by jurors who make decisions based on the evidence presented to them.

The Problem of Induction

The problem of induction calls into question all empirical claims made in everyday life or through the scientific method and, for that reason, the philosopher C. D. Broad asserts that "induction is the glory of science and the scandal of philosophy." Although the problem arguably dates back to the Pyrrhorism of ancient philosophy, as well as the Carvaka school of Indian Philosophy, David Hume introduced it in the mid 18th century.

The original problem of induction can be simply stated thus: *it concerns the support or justification of inductive method;* method that predict or infer, in Hume's words, that "instances of which we have had no experience resemble those of which we have had experience. Such methods are clearly essential in scientific reasoning as well as in the conduct of our everyday affairs. The problem of induction borders on the philosophical question of whether inductive reasoning leads to knowledge understood in the classic sense since it focuses on the alleged lack of justification for either.

1. Generalizing about the properties of a class of objects based on some number of observations of particular instances of that class (e.g. the inference that "all swans we have seen are white and therefore, all swans are white," before the discovery of black swans) or
2. Presupposing that a sequence of events in the future will occur as it always has in the past (e.g., that the laws of physics will hold as they have always been observed to hold.)

Hume calls this the principle of Uniformity of Nature. The problem is how to support or justify the above claims made by induction and it leads to a dilemma: *the principle cannot be proved deductively, for it is contingent and only necessary truths can be proved deductively. Nor can it be validly supported inductively – by arguing that it has always or usually been reliable in the past – for that would beg the question by assuming just what is to be proven.* A century after Hume emphasised the problem and argued that it is insoluble; J. S. Mill gave a more specific formulation of an important class of inductive problem. Mill notes, "Why is a single instance in some cases sufficient for a complete induction, while in others myriads of concerning instance, without a single exception known or presumed, go such a little way toward establishing a universal proposition?"

For example, compare the following two assertions:

i. Everyone seated in the bus is going northward
ii. Everyone seated in the bus was born on a prime numbered day of the month.

It is very easy to accept the first assertion inductively as true because the bus itself is heading northward, but it is illogical to say the same of the second. These inconsistencies are also part of what constitute what is now known as the problem of induction.

Origin of the Problem Prior to Hume

Although David Hume is usually considered as the one that first raised doubts on the validity and justifiability of inductive reasoning, evidence indicates that as early as the ancient period of the development of human reasoning, scholars like Sextus Empiricus had already made such an observation. Pyrrhonian skeptic Sextus Empiricus first questioned the validity of induction, positing that a universal rule could not be established from an incomplete set of particular instances. He notes; "when they propose to establish the universal from the particulars by means of induction, they will affect this by a review of either all or some of the particulars. But, if they review some, the induction will be insecure, since some of the particulars omitted in the induction may contravene the universal; while if they are to review all, they will be toiling at the impossible since the particulars are infinite and indefinite. (see, Sextus Empiricus, *Outlines of Pyrrhonism,* p. 283).

Although, the criterion argument applies to both deduction and induction, scholars believe that Sextus Empiritus' argument "is precisely the strategy Hume invokes against induction: it cannot be justified, because the purported justification, being inductive is circular. Weintraub, commenting on the problem of induction notes that Hume's most important legacy is the supposition that the justification of induction is not analogous to that of deduction.

The Carvaca, a materialist and skeptic school of Indian Philosophy, used the problem of induction to point out the flaws in suing inference as a means of gaining valid knowledge. They held that since inference needed an invariable connection between the middle term and the predicate and further, that since there was no way to establish this invariable connection, that the efficacy of inference as a means of valid knowledge could never be stated (see, S. Radhakrishnam, *Indian Philosophy,* Vol. III, Pg. 533). The 9th century Indian skeptic, Jayarasi Bhalta, also made an attack on inference along with all means of knowledge, and showed by a type of reductive argument that there was no way to conclude universal relations from observation of particular instances (see Franco Eli, *Perception, Knowledge and Disbelief: A Study of Jayarasi Scepticism*, 1927).

Medieval writers such as Ghazali and William of Ockham connected the problem of induction with God's absolute power, asking how we can be certain that the world will continue behaving as expected when God could at any moment miraculously cause the opposite.

Duns Scotus argued that inductive inference from a finite number of particulars to a universal generalization was justified by "a proposition reposing in the soul, whatever occurs in a great many instances by a cause that is not free, is the natural effect of that cause" (Duns Scotus, *Philosophical Writings*, 1962). Some 17th century Jesuits contend that although God could make the end of the world at any moment, it was necessarily a rare event and hence, our confidence that it would not happen very soon was largely justified.

Hume on Induction

The source of the problem of induction as it is known today is Hume's brief argument in Book 1, part 3, section 6 of the *Treatise on Human Nature*. The great historical importance of this argument, not to speak of its intrinsic power, recommends that reflection on the problem begin with a rehearsal of it.

It should be noted that the term induction does not appear in Hume's argument or anywhere in the *Treatise* or the *First Inquiry*, for that matter. Hume's concern is with inferences concerning causal connections which on his account are the only connections which can lead us beyond the immediate impression of our memory and senses (see, *Treatise on Human Nature*, 89). However, the difference between such inferences and what we know today as induction, allowing for the increased complexity of the contemporary notion is largely a matter of terminology. Hume divides all reasoning into demonstrative (by which he means deductive) and probabilistic (by which he means the generalization of causal reasoning). The deductive system that Hume had at hand was just the weak and complex theory of ideas in force at the time augmented by syllogistic logic (*Treatise*, Book 1, Part 3, Section 1). His demonstrations are not same with the usual idea of deductive reasoning but they are founded on the principle which holds that conceivable connections are possible; inconceivable connections are impossible; and necessary connections are those the denial of which are impossible or inconceivable. It should also be noted that Hume's argument against induction applies only to what is known today as enumerative induction.

First, Hume ponders the discovery of causal relations, which form the basis for what he refers to as 'matters of fact.' He argues that causal relations are found not by reason, but by induction. This is because, for any cause, multiple effects are conceivable, and the actual effect cannot be determined by reasoning about the cause; instead, one must observe occurrences of the causal relation to discover that it holds. For example, when one thinks of a billiard ball moving in a straight line toward another, one can conceive that the first ball bounces back with the second ball remaining at rest, the first ball stops and the second ball moves, or the first ball jumps over the second etc. there is no reason to conclude any of these possibilities over the others. Only through previous observation can it be predicted, inductively, what will actually happen with the balls. In general, it is not necessary that causal relation in the future resemble causal relations in the past, as it is always conceivable otherwise. For Hume, this is because the negation of the claim does not lead to a contradiction.

Next, Hume ponders the justification of induction. If all matters of facts are based on causal relations, and all causal relations are found by induction, then induction must be shown to be valid somehow. Hume posits that there is no logical connection between the propositions put together to arrive at an inductive conclusion. He suggests that one connects two or more propositions not by reason but by induction. If a deductive justification for induction cannot be provided, then, it appears that induction is based on an inductive assumption about the connection which could be begging the question. Induction itself cannot validly explain the connection. In this way, the problem of induction is not only concerned with the uncertainty of conclusions derived by induction, but, doubts the very principle through which those uncertain conclusions are derived.

In summary, David Hume questions the strength and justification of inductive reasoning. He argues that induction is an unjustifiable mode of reasoning for the following reasons. One believes inductions are good because nature is uniform in some deep respects. For instance, one induces that all ravens are black from a small sample of black ravens because he believes that there is a regularity of blackness among ravens, which is a particular uniformity in nature. However, why suppose that there is a regularity of backness among ravens? What justifies this assumption? Hume claims that one knows that nature is uniform either deductively or inductively. However, one cannot deduce this assumption and an attempt to induce the assumption only make a justification of induction circular. Thus, induction is an unjustifiable form of reasoning. This is Hume's problem of induction.

Instead of becoming a sceptic about induction, Hume sought to explain how people make inductions, and considered this explanation as a good way of justification of induction that could be made. Hume claimed that one can make induction because of habits. In other words, habit explains why one induces that all ravens are black from seeing nothing but black ravens beforehand.

Nelson Goodman – The New Riddle of Induction

Nelson Goodman (1955) questioned Hume's solution or rather position, with regard to the problem of induction in his classic text, *Fact, Fiction and Forecast.* Although Goodman thought that Hume was an extraordinary thinker, he believed that Hume made one crucial mistake in identifying habit as what explains induction. The mistake is that people readily develop habits to make some inductions but not others even though they are exposed to both observations. Goodman develops the following example to demonstrate his point: "suppose that all observed emeralds have been green. Then we would readily induce that the next observed emerald would be green. But why green? Suppose 'grue' is a term that applies to all observed green or unobserved blue things, then, all observed emeralds have been 'grue' as well. Yet none of us would induce that the next observed emerald would be blue even though there would be equivalent evidence for this induction."

Thus, the New Riddle of Induction is not about what justifies induction, but, rather, it is about why people make the inductions they do given that they have equal evidence to make several incompatible inductions. Goodman's solution to the new riddle of induction is that people make inductions that involve familiar terms like "green" instead of ones that involve unfamiliar terms like "grue" because familiar terms are more entrenched than unfamiliar terms, which simply means that familiar terms have been used in more inductions in the past. Thus, statements that incorporate entrenched terms are "projectible" and appropriate for use in inductive arguments.

Notice that Goodman's solution is somewhat unsatisfying. While he is correct that some terms are more entrenched than others, he provides no explanation for why unbalanced entrenchment exists. More so, he ended up only explaining why induction as a kind of reasoning is always invoked by people in spite of its shortcomings; he did not deal precisely with the questions posed by Hume against induction – that is, how to justify inductive reasoning which Hume considers as flawed.

Willard Van Orman Quine on the Problem of Induction - The Raven Paradox

In order to complete the Goodman's project, Quine, (1956 – 2000) theorizes that entrenched terms correspond to "natural kinds." In 1969, Quine demonstrates his position with the help of a familiar puzzle he borrowed from Carl Hempels (1905 - 1997), known as 'the Raven Paradox.'

It reads: "*suppose that observing several black ravens is evidence for the induction that all ravens are black, then, since the contra-positive of "all ravens are black" is "all non-black things such as green leafs, brown basketballs and white baseballs is also evidence for the induction that all ravens are black. But how can this be?*" Quine argues that observing non-black things is not evidence for the induction that all ravens are black because non-black things do not form a natural kind and projectible terms only refer to natural kinds (eg. "ravens" refer to ravens); thus, they are projectible and become entrenched because they refer to natural kinds.

Even though this extended solution proffered by Quine to the New Riddle of Induction sounds plausible, it is not without any flaw. Several of the terms we use in natural language do not correspond to natural kinds, yet, we still use them in induction. A typical example from the philosophy of language is the term 'game' first used by Ludwig Wittgenstein (1889 – 1951) to demonstrate what he called "family resemblance". Look at how competent English speakers use the term "game". Examples of games are monopoly, card games, the Olympic games, war games, tic-tac-toe, and so forth. Now, what do all of these games have in common? Wittgenstein would say "nothing", or if there is something they all have in common, that feature is not what makes them games. So, games resemble each other although they do not form a kind. Of course, even though games are not natural kinds, people make inductions with the term, "game".

Karl Popper on the problem of Induction

Popper posits that science does not use induction and induction is in fact a myth (see, *Conjectures and Refutations*, p. 53). Instead, knowledge is created by conjecture and criticism. The main role of observations and experiments in science, he argued, is in attempts to criticize and refute existing theories. According to Popper, the problem of induction as usually conceived is asking the wrong question: it is asking how to justify theories given they cannot be justified by induction. Popper argued that justification is not needed at all and seeking justification "begs for authoritarian answer." Instead, Popper said, what should be done is to look to find and correct errors. Popper regarded theories that have survived criticisms as better corroborated in proportion to the amount and stringency of the criticism, but in sharp contrast to the inductivist theories of knowledge, emphatically, as less likely to be true (see, *Logic of Scientific Discovery*, p. 43). Popper held that seeking for theories with a high probability of being true was a false goal that is in conflict with the search for knowledge. Science should seek for theories that are most probably false on one hand (which is the same as saying that they are highly falsifiable and so there are lots of ways they could turn out to be wrong), but still all actual attempts to falsify them have failed so far (that they are highly corroborated).

Popper gave two formulations of the problem of induction. The first is the establishment of the truth of a theory by empirical evidence; the second, slightly, weaker is the justification of a preference for one theory over another as better supported empirically. He declared both of these as insoluble on the grounds that scientific theories have infinite scope and no finite evidence can ever adjudicate among them. He did however hold that theories can be falsified and that falsifiability or the liability of a theory to counter example was a virtue. Falsifiability corresponds roughly to the proportion of models in which a (consistent) theory is false. Highly falsifiable theories thus make stronger assertions and are in general more informative. Though, theories cannot be corroborated; a better corroborated theory is one that has been subjected to more and more rigorous tests without having been falsified. Falsifiable and corroborated theories are thus to be preferred, though, as the impossibility of the second problem of induction makes evident, these are not to be confused with support by evidence.

Wesley C. Salmon criticizes Popper on the grounds that predictions need to be made both for practical purposes and in order to test theories. That means that Popperians need to make a selection from the number of unfalsified theories available to them, which is generally more than one. Popperians would wish to choose well-corroborated theories, in their sense of corroboration but face a dilemma; either they are making the essentially inductive claim that a theory's having survived criticism in the past means it will be a reliable predictor in the future; or Popperian corroboration is no indicator of predictive power at all, so there is no rational motivation for their preferred selection principle.