UNIT 1 MEANING AND KINDS OF REASONING

Contents

1.0 OBJECTIVES

In this unit you will become familiar with the role played by reasoning and inference in the development of logic. You will be exposed to objections to interpret logic as concerned with reasoning and inference and consequent change in the meaning of these words. The next section deals with intricate features of two forms of inference followed by the limits and attempts to justify criticisms made against these two forms. It may appear to be a repetition of what was said in the previous block. But it is not so. Discussion of these issues is an extension of earlier exposition. At the end of the unit you should be able to:

- distinguish classical logic from modern logic
- understand why modern logic deviated from the path of classical logic
- to make a subtle distinction between universalization and generalization
- make a close association between logic and mathematics

1.1 INTRODUCTION

It is profitable to contrast deductive inference with inductive inference within the framework of classical logic, before we undertake a detailed critical survey of induction within the gambit of contemporary philosophy. One of the characteristics of deductive logic is its formal character in virtue of its emphasis upon the structure and form of argument. It also functions as a 'criterion of demarcation', to borrow the phrase from Karl Popper, to distinguish deductive inference from inductive inference. Secondly, reasoning is one of the terms often used as synonymous with inference. Therefore it is desirable to consider various aspects of these two words also. Let us begin with the second aspect first.

1.2 MEANING OF REASONING AND INFERENCE

Reasoning consists, essentially, in the employment of intellect, in its ability to 'see' beyond, and 'within' as well, what is available to senses. Reasoning, therefore, can be regarded as an instrument which enables mankind to grasp 'unknown' with the help of 'known'. While reasoning can be regarded as an instrument, inference can be regarded as the process involved in extracting what is unknown from what is known. This is precisely the content of argument, the essence logic. And this is the way knowledge keeps growing.

1.3 OBJECTIONS AGAINST REASONING AND INFERENCE

Whatever is said about inference in this particular section applies more or less to reasoning. One argument which goes against inference is that it is beset with psychological overtones. What is afflicted with psychological overtones is essentially subjective. Logic, in virtue of its close association with knowledge, has nothing to do with anything that is subjective. Cohen and Nagel for this particular reason chose to use 'implication' instead of 'inference'. The difference can be understood easily when we look at the usage. Statements always 'imply' but do not 'infer'. I 'infer', but I do not 'imply'. Salmon fell in line with Cohen and Nagel when he said that the very possibility of inference depends upon reasoning. However, logicians like Copi, Carnap, Russell etc., chose to retain the word inference. But, all along, they only meant implication. Therefore keeping these restrictions in our mind let us freely use 'inference'.

Though the use of the word 'reason' is not much rewarding, the word 'reasonableness' has some weight. We often talk about reasonableness of conclusion. In this context reasonableness means 'grounds of acceptability'. Surely, in this restricted sense, reasonableness is objective just as inference is.

1.4 KINDS OF REASONING

If deductive logic is characterized by form, which also serves as a reliable 'criterion of demarcation' (1.0), then inductive logic must be characterized by something else (since reasoning, inference and logic are used as synonymous, any word can replace any other word). It is claimed that in inductive logic matter or content is primary as opposed to deductive logic. In order to understand the differences we must know a little about the nature of deductive and inductive inferences. These issues shall be addressed now.

When we deal with the form of deductive argument, we also deal with 'valid' and 'true', on the one hand, and 'invalid' and 'false', on the other. This particular distinction is very prominent. Only statements are true (or false) whereas only arguments are valid (or invalid). This distinction will take us to this table.

Table 1:

	Statements	**Arguments**
1)	True	Valid
2)	True	Invalid
3)	False	Valid
4)	False	Invalid

This table helps us to understand the following distinction. a) A valid argument (1 and 3) may consist of completely true statements or completely false statements or both true and false statements. b) An invalid argument (2 and 4), similarly, may consist of statements in exactly the same manner mentioned above. Therefore it means that truth and validity may or may not coincide. Similarly, we have to distinguish between material truth and logical truth. Material truth is what is stated by matter of fact. Logical truth is the outcome of the structure of argument. We shall consider examples which correspond to four combinations (see table1). Let us call premises p1, p2, etc. and conclusion q.

Arg1:

p1: No foreigners are voters.

p2: All Europeans are foreigners.

q: ∴ No Europeans are voters.

Arg2:

p1: Some poets are literary figures.

p2: All play writers are literary figures.

q: ∴ some play writers are poets.

Arg3:

p1: All politicians are ministers.

p2: Medha Patkar is a politician.

q: ∴ Medha Patkar is a minister.

Arg4:

p1: 3 is the cube root of – 27.

p2: - 27 is the cube root of 729.

q: ∴ 3 is the cube root of 729.

(It is sufficient to accept that in the above mentioned argument all three propositions are false.)

These four arguments apply to serial numbers 1, 2, 3, and 4 respectively. First and third arguments have a definite structure in virtue of which they are held to be valid. While second and fourth arguments have a different structure which makes them invalid. When an argument is valid the premise or premises imply the conclusion. If there is no implication then the argument is invalid. Validity is governed by a certain rule which can again be represented in a tabular form. [Let us designate 'true' by 'T' (1) and 'false' by 'F' (0) as a matter convention].

Table 2:

	p	q	
1)	T(1)	T(1)	Valid
2)	F(0)	F(0)	Valid
3)	F(0)	T(1)	Valid
4)	T(1)	F(0)	Invalid

We can also say that the premises necessitate the conclusion. In this case, necessity is of a particular kind, i.e., it is logical necessity. Therefore, when there is implication, conclusion is necessarily true. Very often, deductive logic is identified with mathematical model. It is generally admitted that in both these disciplines information provided by conclusion is the same as the one provided by the premises. It means that both are characterized by material identity. Deductive argument, therefore, is an example for tautology. We say that an argument is tautologous when the combination of statements is true under all circumstances.

If, one can ask, the conclusion does not go beyond premises and no new information is acquired in the process, then why argue and what is the function of arguments? The answer is very simple. Knowledge is not the same as mere acquisition of information. Novelty is not a measure of knowledge. The legend is that Socrates extracted a geometrical theorem from a slave purported to be totally ignorant of mathematics. The moral is that knowledge is within, not in the sense in which brain or liver is within. Knowledge is the outcome of critical attitude. Knowledge is discovered, not invented and so goes the ancient Indian maxim: eliminate ignorance and become enlightened. If what is said is not clear, then consider this path. Deductive argument helps us to know what is contained in the premises, i.e., the meaning of the premises. It is an excursion into the analysis of the meaning of the premises. And the conclusion is an expression of the same. If so, it is easy to see how the denial of conclusion in such a case amounts to denying the meaning of the premises which were accepted earlier. What is called self-contradiction is exactly the same as the combination of denial of conclusion and acceptance of premises. Therefore we say that a valid deductive argument is characterized by logical necessity. Hence a deductive argument is tautologous. It means that it is always true.

At this stage, two terms will be introduced; *analytic* and *a priori*. Consider this example: 'all men with no hair on their heads are bald. We know that this statement is true in virtue of the meaning of the word 'bald'; not otherwise. Such a statement is called analytic. In such statements the predicate term (here 'bald') is contained in the subject term (here 'men with no hair on their heads'). Knowledge obtained from an analytic statement is necessarily a priori, i.e. knowledge prior to sense experience. In philosophical parlance all analytic statements are necessarily a priori. Deductive logic provides knowledge a priori, though the premises and conclusion considered separately are not analytic. However, deductive argument and analytic statement share a common characteristic; in both the cases denial leads to self-contradiction.

How do we say that deductive logic provides a priori knowledge? Consider an example.

Arg. 5: All saints are pious.

All philosophers are saints.

$\therefore$ All philosophers are pious.

Evidently, there is no need to examine saints and philosophers to know that the conclusion is true. Indeed, it is not even necessary that there should be saints who are pious as well as philosophers. This being the case, arg. 5 takes the following form without leading to distortion of meaning.

Arg. 5a: If all saints are pious and all philosophers are saints, then all philosophers are pious.

The argument is transformed into a statement which involves relation. All implicatory relations (the present relation is one such) are such that without the aid of sense

experience, but with the laws of formal logic alone, it is possible to derive the conclusion. Thus like an analytic statement, any valid deductive argument provides a priori knowledge and hence it is devoid of novelty. Deductive argument is properly characterized as logically necessary. It is improper to characterize deductive argument as absolutely certain. Being a priori is one thing and being absolutely certain is something different. At this point, it is not necessary to discuss in detail the differences between absolute necessity and logical necessity. It is sufficient to know that absolute certainty is not to be confused with logical certainty. While the former is not the same as a priori, the latter is. The difference is that absolute necessity is psychological and hence subjective whereas logical necessity is logical and hence objective.

When sense experience takes back seat, intellect or reason becomes the prime means of acquiring knowledge. Following the footsteps of Descartes, who is regarded as the father of rationalism, we can conclude that deductive logic is rational. So we have sketched three characteristics; logical necessity, a priori and rational. One character presupposes another because there is a thread which runs through these characteristics.

Deductive argument is characterized by qualitative difference in opposition to quantitative difference, i.e. differences between valid and invalid arguments are only in kind but not in degree. Let us make matters clear: a valid argument cannot become more valid in virtue of addition of premise or premises. On the other hand, if any one premise is taken out of a valid argument, then the argument does not become 'less valid'. On the contrary, it simply becomes invalid. So an argument is either valid or invalid. Validity is not a matter of degree. Therefore a valid argument is said to be satiated. This is what we mean when we say that the premises in a valid argument constitute necessary and sufficient conditions to accept the conclusion. An argument is invalid due to a 'missing link' in the class of premises.

We have learnt that validity is an important facet of deductive logic. Now it is time to understand the formal characters of deductive logic. Strawson lists three aspects of formal logic: generality, form and system. Generality is distinguishable, clearly, from matter. Generality means that individual is not the subject matter of logic. Formal logic concerns only with the relation between statements, but not objects. This is because it is futile to embark upon a study involving objects because such a study has only beginning but no end. Consider two examples,

Arg6:

p1: The author of Abhijnana Shakuntala was in the court of king Bhoja.

p2: Kalidasa is the author of Abhijnana Shakuntala.

q : $\therefore$ Kalidasa was in the court of king Bhoja.

Arg 6A:

p1: The author of Monadology was in the court of the queen of Prussia.

p2: Leibniz is the author of Monadology.

q: $\therefore$ Leibniz was in the court of the queen of Prussia.

It is easy to decide prima facie that the structure of these two arguments is identical. The difference consists in subject matter only and it is possible to construct countless arguments having an identical structure. Obviously, this is not a profitable exercise. The essence of formal logic consists in saying that p1 & p2 imply q or that q follows from or entails p1& p2. Only implication and entailment are relevant here. Strawson

has made very clear this aspect. Implication or entailment is independent of subject matter. Therefore it is impossible to identify the subject matter in virtue of recognition of implication. This point can be further clarified with the help of variables. Let us represent Abhijnana Shakunthala or Monadology with x, Kalidasa or Leibniz with y and queen of Prussia or King Bhoja with z. Now the argument takes this form.

Arg6': p1: The author of x was in the court of z.

p2: y is the author of x.

q : ∴ y was in the court of z.

In this particular context, without knowing the contents of x,y,and z we can know that p1 and p2 together imply q. The same explanation holds good to any invalid or inconsistent argument.

Let us call such forms logical forms. A logical form has two components: variables and constants. x, y, z etc are variables. 'If …….then, or, and, not' and 'if and only if' are called logical constants. In the final analysis, the structure of an argument is determined by constants, but not variables. The dependence of the laws of an argument on constants can be illustrated in this way. In life science the classification of animals is an important topic. The anatomical features of birds and aquatic creatures differ and there is difference in the function of those organs. Just as birds have some organs in common, aquatic creatures have certain other organs in common. These common organs correspond to constants. Similarly, every class of argument has definite constants. Just as the structure of birds is different from the structure of aquatic creatures, the structure of one class of arguments is different from the structure of some other class of arguments. The laws which explain the function of the organs of birds are different from the laws which explain the function of the organs of aquatic creatures. Similarly, when the structure of an argument differs, the laws also differ.

Integration of rules is another characteristic of formal logic. The structures of argument and rules are mutually dependent. If it is possible to decide the structure of an argument and also different classes of arguments, then is possible to achieve what is called formalization or systematization.

Deductive argument is also regarded as demonstrative argument, because the premises offer conclusive evidences for the conclusion. Acceptance of premises leaves no room for any reasonable or meaningful doubt. On the contrary, induction stands for any non-demonstrative argument where the premises, irrespective of their number, do not and cannot offer conclusive evidences to the conclusion. The word 'induction' is the translation of what Aristotle called 'epagoge'. C.S. Peirce called them 'ampliative', because in this type of argument the conclusion always goes beyond the premises and the premises offer, at best, reasonable grounds to 'believe' such conclusion. Belief is not the same as proof, a distinction which was, more often than not, completely ignored by the protagonists of induction. This is one difference. Secondly, all characteristics of induction are opposed to deduction. Uncertainty and sense experience characterize any inductive argument. Let us consider the second character first. This type of argument begins with sense experience. The premises, therefore, can be called 'observation-statements which directly result from experience. However, the conclusion is not an observation statement because it overshoots the material provided by observation statements which is why the observation statements cannot justify the conclusion. No matter how many black crows I have seen, it cannot prove or justify that 'all crows are black.' In this example black crows which I have seen form the matter of observation statements. The statement 'all crows are black' not only includes observed crows, but also includes crows which have not

been observed by me. It is the second component which is the root cause of endless debate on the nature of inductive inference.

At the outset, it is necessary to dispel a widespread and deep-rooted misconception. Inductive argument, it is held erroneously, always provides universal statement. On the contrary, what it provides is merely a statement which depends upon experience, but in itself is not an experiential statement. On some occasions, experience can vouch for the conclusion, but on some other occasions, it cannot. For example, considering the fact that, today I observed 5384 black crows, I may conclude that 'tomorrow I will observe the same number of black crows'. This sort of conclusion is characterized by a sort of leap, leap from 'observed to unobserved or unobservable'. This is called inductive leap which always results in generalization. Induction cannot even be conceived in the absence of generalization. Thus generalization is the hallmark of induction. However, a universal statement differs from generalization because it is possible to construct a universal statement within the limits of sense experience without involving generalization, for example, when I conclude after close scrutiny that every book in the library is a hardback edition, the conclusion is universal but it is not an instance of generalization because there is no leap from observed to unobserved or unobservable.

The example considered above is future-oriented and in principle, it is 'verifiable'. However, inductive inference need not be so always. It can also be past-oriented which is surely, 'unverifiable'. History, anthropology, Geology, etc. consist of arguments which are past-oriented. But the mechanism, involved in both the cases is exactly the same. Therefore the prime characteristic of induction is that the conclusion does not necessarily follow from the premises and that experience precedes inference which means that inductive inference is uncertain and *a posteriori*. Whatever knowledge we acquire 'after experience', or whatever depends upon experience is called *a posteriori* as opposed to a priori.

While logical certainty and a priori knowledge provided by deductive logic entitles it to be loosely called rational, uncertainty and a posteriori knowledge provided by inductive logic entitles it to be called empirical a character disputed by Popper. We will consider his arguments at a later stage. The uncertainty of inductive conclusion prompts us to introduce another basic term in philosophy, viz. 'probability'. However, before we consider the probable nature of inductive conclusion some remarks on 'content' and 'truth' are needed.

Inductive inference is not formal in the sense that more than structure, the subject matter is relevant which is why the acceptability or relevance of the conclusion varies from one argument to another. Consider these examples:

Arg7:

Over the years, the scientists compared finger prints of over a 'million number' of people and observed that none of them was identical with any other.

$\therefore$ No two finger prints in the world at any point of time are alike.

It is very easy to think that this particular conclusion is based on just one premise. In reality, it is based upon 'over a million number' of premises. A judgment on every pair of fingerprints is, indeed, a premise. Another important point to be noted is that this conclusion is not restricted by spatio-temporal factors. Compare the previous argument with this argument.

Arg8:

Thalidomide was administered to a large number of pregnant women as an antidote

to morning sickness. In a significant number of those cases, infants developed physical deformity.

∴ This drug is likely to be harmful in future also.

The difference is that Arg7 does not include any exception whereas the Arg8 includes exceptions. Secondly, the former is taken to be beyond all reasonable doubts whereas the latter is not. Yet the second argument yields conclusion which is accepted in spite of contrary facts whereas the first argument yields conclusions which may be doubted. That it is not doubted is altogether different. It is possible that these two arguments enjoy credibility at different levels. What is important is that in none of these cases can we say that the conclusion is true because the premises do not imply the conclusion.

This analysis makes two points clear. Content alters the acceptability of argument and inductive argument is neither valid nor invalid. In other words, an inductive conclusion is neither true nor false. At best it is probable and at worst it is improbable.

Probability is a matter of degree. Assume that truth takes value '1' and falsity takes value '0'. Then the numerical value of probability varies from 0 to 1 without reaching either lower limit or upper limit. At this stage, it is enough to point out that the favourable premises raise the probability value. Therefore an inductive argument may consist of any number of premises, but what makes an argument more acceptable or less acceptable is the probability value that it takes. So we shall replace 'valid' and 'invalid' by 'good' and 'bad' and consequently, an inductive argument is either good or bad depending upon the level of its acceptability.

In deductive logic it is impossible to deny the conclusion, when the premises are accepted as true, without contradicting one's own self. How can an inductive argument escape from contradiction? The response is obvious. Conclusion includes more information than the premises. After accepting the premises if we deny the conclusion, we deny only that component of the conclusion which does not coincide with the premises. Therefore denial does not imply contradiction. The relation between premises and conclusion is very much akin to 'synthetic' as opposed to 'analytic' judgments where the meanings of subject and predicate are different, but otherwise related as in the case of the statement, 'The height of Mt. Everest is 29,000ft'. It is possible to ascertain the truth or falsity of such propositions, but it is not possible to know it a priori. So it was thought that all synthetic statements are necessarily *a posteriori* until Kant expressed his doubts on this issue. He tried to establish synthetic a priori propositions in order to counter Hume's attack on some metaphysical principles. Had he succeeded in doing so the development of inductive logic would have taken place in a very different direction.

1.5 ARGUMENTS AGAINST DEDUCTION AND INDUCTION

While deductive inference is exposed to less number of and less serious criticisms, induction is exposed not only to more serious criticisms, but also is attacked on more than one ground. While some of them find place in another unit, one particular criticism is considered here. Though this criticism was made by J.S. Mill with reference to one type of deductive argument known as syllogism, in general, any deductive argument is affected by this character. Mill contends that syllogism is guilty of repeating the premises in the conclusion without moving further. This criticism applies to inference within the limits of classical logic, where only true premises are considered or where the premises are taken to be true. When such premises and conclusion are conjoined,

we get what is called compound statement and such statement is called tautology, because the same thing is said twice. The aim of logic is to achieve progress in knowledge. Deductive logic fails to achieve this particular aim. This objection can be effectively answered as has been pointed out early (1.4).

But the problem is more serious with induction. In the first place, induction is not regarded as logic at all since the truth of the conclusion does not follow necessarily from the truth of premises. Promptly, this objection was met by the defenders of induction by arguing that deductive standard ought not to be applied to inductive logic, lest the distinction itself becomes superfluous. As an alternative measure, some inductivists proposed what are called self-supporting inductive arguments. But any attempt to support one inductive argument with any inductive principle, if there is one, will, surely, lead to arguing in circle. This is so called because in this type of argument we are assuming what has to be proved which is a fallacy.

For quite some time it was believed that science follows a certain type of method which starts with observation of facts and ends up with generalization in the guise of law. This was the view of Bacon. Popper targeted induction precisely for this reason. While self-supporting inductive arguments involve arguing in a circle, any other attempt to justify induction results in infinite regress, i.e., if we use one principle to justify a law in science, then this principle stands in need of justification, and so on. This is what is known as infinite regress. These issues will engage our attention later (see unit 1 of block 3).

1.6 KINDS OF GENERALIZATION

While the type of deductive conclusion remains the same, the type of generalization differs. Broadly speaking, there are three types of generalization unrestricted generalization, restricted generalization and statistical generalization. Accordingly, induction also is of three types: unrestricted, restricted and statistical [instead of generalization, universal also can be used]. Generalization is said to be unrestricted when it does not include exception in any form. There are three types of restricted generalization; individual, spatial and temporal. Three illustrations are required to make this point clear.

1) Tendulkar will score a century in the next match.

2 All those who live in India are Hindus.

3 All those who lived before 20th century were religious.

However, unrestricted generalization is free from any of these types of restrictions. The following statement illustrates this type.

4) All celestial bodies revolve in elliptic orbit.

Generally, restricted universal or generalization allows complete enumeration. But unrestricted generalization does not allow. Inductive logic in general and science in particular do not take enumeration seriously. Aristotle, indeed, regarded complete enumeration as one type of induction. It is important to note that complete enumeration does not generate generalization because there is no jump from 'observed' to 'unobserved'. Therefore it cannot even be regarded as inference. He was perhaps aware of this limitation. In some other place, he said that it is a kind of syllogism. Even then complete enumeration ceases to be induction. These problems forced Aristotle to propose another type which he called 'intuitive induction'. He defined it as '…a kind of induction which exhibits the universal as implicit in the clearly known particular'.

Analogy can be regarded as an example for intuitive induction. But the case of analogy is very different. Analogy excludes generalization of all types. Still, it is inductive, because with its help we pass from 'observed' to 'unobserved'. In this case, we notice certain similarities and over and above that a quality in one particular object but not in another. Then we infer that these objects (or persons) must be similar with respect to newly detected quality. This particular inference is, evidently, intuitive. Intuition is, essentially, subjective. But in this case the subjective nature of intuition does not pose any problem because what is inferred can be tested by anyone. Hence, analogy can be regarded as objective and also as inference.

Development in certain fields like statistics has given rise to a different type of generalization which may be called statistical generalization. Statistical generalization requires fair sample within which a study is undertaken yielding a certain ratio. This is, surely, an example for empirical approach. Observations made within this sample are extended to the parent class, i.e. the class of which the sample forms a part. It is quite likely that we may arrive at a certain ratio within fair sample whereas within the parent class we may arrive at some other ratio if certain other parameters influence the rest of the class. Another type of statistical generalization results when observations made in one sample become the ground to make observations in some other sample. In all such studies, it is frequency of occurrence of an event which matters. It is of utmost importance that in any statistical study fair sample should consist of elements selected by the same procedure.

In this context, a pertinent question arises. When does a sampling become fair? To be more precise, where can we draw the line demarcating fair sample from not so fair? To be sure, there is no such clear demarcation. Largely, it is a matter of convention which decides the fairness of a certain sample.

Check Your Progress I

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

1) Analyse the relation between validity and formal character of deductive logic.

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2) Bring out the meanings of 'analytic and synthetic' and 'a priori and a posteriori'.

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3) Give examples (must be your own) for valid arguments consisting of only false statements and invalid arguments consisting of only true statements.

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4) Analyse the characteristics of induction.

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5) Comment upon the criticisms made against deductive and inductive inferences.

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6) Distinguish different types of generalization.

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1.7 LET US SUM UP

Inference or reasoning is of two types: inductive and deductive; deduction is formal and it is valid or invalid. Valid argument may consist of either true statements or false statements. Deductive inference is known a priori. Sense experience is irrelevant in deductive logic. Intellect is the key to deductive inference. Denial of conclusion leads to contradiction. Logical certainty, a priori nature and rational are the qualities of deduction.

Inductive inference is uncertain, *a posteriori* and empirical. Induction is regarded only by some as empirical. Inductive conclusion is the same as generalization. Generalization and universal are not same. In induction content determines acceptability whereas in deduction form determines validity. Probability is a matter of degree which is always a variable fraction. Deduction, it is said, is tautological whereas induction is neither an inference nor a method of science. Generalization is of three types: restricted, unrestricted and statistical.

1.8 KEY WORDS

Axiom : In traditional logic, an axiom or postulate is a proposition that is not proved or demonstrated but considered to be either self-evident, or subject to necessary decision. Therefore, its truth is taken for granted, and serves as a starting point for deducing and inferring other (theory dependent) truths.

1.9 FURTHER READINGS AND REFERENCES

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1.10 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress I

1) One of the characteristics of deductive logic is its formal character in virtue of its emphasis upon the structure and form of argument. Reasoning is also one of the formal characters of the deductive logic. Reasoning can be regarded as the process involved in extracting what is unknown from what is known. When we deal with the form of argument we also deal with 'valid' and 'true' on the one hand and 'invalid' and 'false' on the other. This particular distinction is very prominent. Only statements are true (or false) whereas only arguments are valid (or invalid).

2) we shall begin with an example: 'all men with no hair on their heads are bald ', We know that this statement is true in virtue of the meaning of the word 'bald'. Such a statement is called analytic. Knowledge obtained from an analytic statement is necessarily a priori, i.e. knowledge prior to sense experience. Deductive logic provides knowledge a priori, though the premises and conclusion considered separately are not analytic. However, deductive argument and analytic statement share a common characteristic. In both the cases, denial leads to self-contradiction. Any knowledge before experience is a priori and that knowledge which comes after experience is called a posteriori.

3) p1: All Indians are cricket lovers.

   p2: Adolf Hitler is an Indian.

   $\therefore$ Adolf Hitler is a cricket lover.

   This argument is valid but the statements are not true.

   p1: Some singers are musicians.

   p2: All play writers are musicians.

   q: $\therefore$ some play writers are singers.

   This argument is invalid but the statements may be true.

4) The word 'induction' is the translation of what Aristotle called 'epagoge". In this type of argument the conclusion always goes beyond the premises and the premises offer, at best, reasonable grounds to 'believe' such conclusion. Belief is not the same as proof, a distinction which was, more often than not, completely ignored by the protagonists of induction. This is one difference. Uncertainty and sense experience characterize any inductive argument. Let us consider the second character first. This type of argument begins with sense experience.

The premises, therefore, can be called 'observation-statements which directly result from experience. However, the conclusion is not so because it overshoots the limits of observation statements which is why the observation-statements cannot justify the conclusion. No matter how many black crows I have seen, it cannot prove that 'all crows are black.' The prime characteristic of induction is that the conclusion does not necessarily follow from the premises and that experience precedes inference, which means that inductive inference is uncertain and a posteriori. Whatever knowledge we acquire 'after experience', or whatever depends upon experience is called a posteriori as opposed to a priori.

5) Induction has attracted more number of criticisms than deduction. The criticism against deduction was made by J.S. Mill with reference to one type of deductive argument known as syllogism. However, in general any deductive argument is affected by this character. Mill contends that syllogism is guilty of repeating the premises in the conclusion. This criticism applies to inference within the limits of classical logic, where only true premises are considered or where the premises are taken to be true. When such premises and conclusion are conjoined we get what is called compound statement and such statement is called tautology, because the same thing is said twice. The aim of logic is to achieve progress on knowledge. Deductive logic fails to achieve this particular aim.

   Induction, on the other hand is open to more serious criticisms. Induction is not regarded as logic at all since the truth of the conclusion does not follow necessarily from the truth of premises. Popper targeted induction for another reason. For quite some time it was believed that science follows a certain type of method which starts with observation of facts and ends up with generalization in the guise of law. This particular view came under attack by Popper.

6) There are three types of unrestricted generalization, restricted generalization and statistical generalization. 'Sachin will score a century in the next match' is a restricted generalization but 'all celestial bodies revolve in elliptic orbit' is the unrestricted generalization. Generalization is said to be unrestricted when it does not include exception in any form. Unrestricted generalization is free from any type of restrictions, whereas the other types are not. Restricted universal or generalization allows complete enumeration.