UNIT 1 INTRODUCTION TO LOGIC*

Structure

1.0 OBJECTIVES

The objectives of this unit are,

* Prof. Enakshi Ray Mitra, Professor, Department of Philosophy, Faculty of Arts, University of Delhi.

- to introduce the basic theme of Logic, its subject-matter, its nature and scope and the questions and issues it primarily deals with.
- to identify the issues that fall beyond its purview.
- to give an overview of the principal sub-divisions within this subject, giving an indication about the *kinds* or *species* of Logic that gradually emerge from its broadest characterization or its genus. While the key terms and concepts of Logic get addressed in the natural course of this elucidation, they are not posed in a technical format, but rather as common-sense notions embedded in our intuitive understanding of the subject.
- to discuss the difference between the Western and Indian approaches to Logic.

1.1 INTRODUCTION

Logic is a kind of normative science that needs to be distinguished from descriptive sciences on the one hand and other normative sciences (Ethics and Aesthetics) on the other. The distinction between two major branches of Logic – Inductive and Deductive - is articulated in a way that ensures a necessary transition from the former to the latter. This in its turn invites a comparison between the Western and Indian approaches to this discipline, showing the latter as having a more expansive purview, moving beyond the *decontextualised* and *formal validity* of arguments. The provision within some Indian theories of logic, of incorporating the mechanism of knowing general essences that form the basis of arguments, has also been discussed. Lastly the way Western Logic moves from preliminary tools to incorporate more and more complex kinds of arguments have been indicated.

1.2 DEFINITION OF LOGIC – ARGUMENT AND PROPOSITION

Logic is a science which teaches you to argue correctly. This would mean that Logic deals with the norms or standards of valid arguments.

What is an Argument? It is a set of (at least two) propositions in which one or more propositions are claimed to be the ground of another proposition to be deduced. The ground propositions are called 'premises/premisses[*]' and the deduced proposition is called 'conclusion'.

What are Propositions? Propositions are meanings of indicative sentences. Indicative sentences are those which, as contrasted with questions, commands, optations, etc., can be used to make statements that are true/false.

Arguments can be composed only of propositions or statements and not of questions or commands.

Take the stock example of an argument:

All men are mortal

Ram is a man

∴ Ram is mortal

All the constituent sentences are indicative. Suppose we turn each of these statements into other non-indicative moods –

Are all men mortal?

Oh I wish Ram were a man!

From these two sentences we cannot derive any other sentence – either in an indicative or in a non-indicative mood. So we need propositions for constructing arguments in Logic.

1.3 DEMARCATING LOGIC FROM OTHER DESCRIPTIVE SCIENCES

Logic is not a descriptive study like History, Geography, Physics, Chemistry, Biology or Anthropology. These disciplines deal with observation and discovery of facts, and many of them

[*] *Premise* and *Premiss*, both, are used interchangeably.

conduct experiments to find out new facts. Logic does not undertake observation or description of facts, nor experiments to enable fresh discovery of facts

Logic in its broadest sense deals with the *ways and norms* of observing facts and of gleaning information from the natural world. The special force of logic however consists in this query - once facts are procured what will be the ways of moving to new facts, not on the basis of new observations and experiments, but on the basis of already known facts, coupled with the *norms of reasoning*.

Let us try to understand with an example as to how Logic- in the broadest sense of the term - carries out these two basic agendas.

Logic will discriminate between the proper and improper ways of forming generalization. Take two generalities-

i. All mammals are warm blooded
ii. All incidences of malaria are cured by chloroquine phosphate.

The above generalities are formed by proper methods of scientific enquiry – e.g. further investigation into the physiology of mammals and its possible connection with their being warm blooded, or empirically confirming that each malaria patient gets cured by administering the chloroquine drug and careful recording of any negative instance.

By contrast take the general statements - All crows are black or All crows peck when a human approaches their nest. Such generalizations are based on a loose collection of superficial observation, and not on any attempt to record counter examples, setting up control groups, or a deeper probe into the biological constitution of the crows. Now once these generalities like (i) and (ii) are established in the respective sciences logic will further teach us the proper ways of arriving at new facts - without any further observation. For instance, suppose someone argues –

All cases where anthrax antitoxin is administered to an animal affected by this disease will be cured.

This Anthrax -infected cow has been cured.

・It has been given the anthrax antitoxin.

Here Logic will point out that this argument is invalid. It was never a claim of the initial generalization that anthrax antitoxin is the only antidote of Anthrax, for there may be other ways of curing the infection. From an affirmation of an Anthrax patient's cure one cannot deduce the conclusion that it had been treated with the unique antidote.

Here we find an invalid argument where Logic identifies a general form of invalidity. This invalid form is –

If P then Q

Q

- **P**

This invalid form has a corresponding form of validity which is –

If P then Q

P

- **Q**

These forms or laws of validity and invalidity are not derived from experience. Nor are the norms of forming correct generalizations, though they take help of experience, they are not exclusively based on experience. So logic is not an empirical science that describes and records experiential data. It deals with the norms or standards - not only of finding and describing new data - but mainly with the *norms of deducing new statements exclusively from the old and familiar ones, without the aid of any further experience*.

- The first agenda of finding the standards of correct discovery and formulation of facts belongs to a particular branch of Logic viz. *Inductive Logic.*
- The second task of deducing further facts from the facts that are already established independent of experience, defines the nature and scope of *Deductive Logic.*

(Learners are advised to substantiate their answers by using their own illustrations and examples, wherever applicable.)

Check Your Progress I

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

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

1. Why is Logic a normative science?

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1.4 INDUCTIVE LOGIC- PROVIDING THE TOOLS OF SCIENTIFIC INQUIRY

Inductive Logic is claimed to improvise norms of discovering new facts and establishing scientific law statements. But it is important to appreciate that this does not turn Inductive Logic into the descriptive sciences like History, Geography, Physics or Chemistry. To find out the proper ways of utilizing our faculty of experience, or articulating the norms of establishing law statements with the aid of experience is not the same as conducting an actual empirical investigation – say conducting a survey of the relics of an ancient civilization or examining old documents for exploring the incidents of remote past. Nor does Inductive Logic include such activities as mixing two gases, viz. Hydrogen and oxygen in a definite proportion to find out whether they combine to form water.

Then what is exactly the task of formulating the norms of establishing general or particular facts with the aid of1 experience? Here we can outline the content of Inductive Logic in broad brushes – by a brief survey of the norms of empirical investigation and of establishing scientific generalities - as laid down by this discipline.

- **Mill's Methods of Experimental enquiry**

i. Method of Agreement

ii. Method of Difference

iii. Joint Method of Agreement and Difference

iv. Method of Concomitant Variation

v. Method of Residues

- **Analogical Arguments**

- **Science and Hypothesis**

i. Difference between Scientific and Unscientific Explanation.

ii. Criteria for Evaluating Scientific Explanation

iii. Application of the norms of good hypothesis to concrete cases of scientific investigation

A more concrete idea about these norms can be shaped up by considering the first of Mill's methods – viz. The Method of Agreement

A simplified statement of this method runs as follows –

The one factor or circumstance that is *common* to all the cases of the phenomenon under investigation is likely to be the cause (or effect) of that phenomenon.

The scientist intending to find out the cause of malaria goes on collecting as many instances as possible. He may note that the instances collected so far share a common circumstance - viz. the patient caching cold. However if he goes on to generalize that malaria is a disease that is caused by the virus of cold. It will not satisfy the Method of Agreement stated above. Cold may not be the *only* circumstance shared commonly by all the instances recorded so far; the crucial factor of mosquito bite has been ignored in this investigation. Besides a more comprehensive intake of the data will show that not *all* the cases of malaria agree to the circumstance of catching cold; patients without such precedents also come to be affected by this disease. This discovery will lead the scientist to discard the factor of catching cold, or eating a particular kind of food, or a skin infection, etc., as being the possible causes of malaria. Once the mosquito bite has been identified as the *only* circumstance in which *all* the instances agree, further investigation will help the scientist identify a particular species of mosquito - viz. anopheles – as being the carrier of the malarial germ.

From this simple instance we can appreciate that Inductive logic provides valuable tools for all the empirical sciences, though it itself is not an empirical science. Investigation into the

virological details of cold, the physical features of the areas showing the maximum incidence of malaria, microscopic dissection of the anopheles mosquitoes, will not enter into the purview of Inductive Logic. It will stay aloof of these fleshy and raw details of the material world to prescribe abstract norms of empirical investigation.

It should be noted that these norms of scientific investigation – say Mill's methods – apply not only to biology, physiology or virology, but also to physics and chemistry, as well as to the social sciences like history, geography, sociology, economics, cultural studies, feminist studies, and even to literature and linguistics. Lastly, since Logic is the method of all disciplines, it is also a method of Philosophy, rather Logic is an essential component of Philosophy.

1.5 THE DISTINCTION BETWEEN LOGIC AND PSYCHOLOGY

Logic should not also be confused with another descriptive science, viz. psychology. Psychology deals with our mental processes like cognition, feeling and willing. When we have cognition of the general facts of Nature, when we consider the norms of experimental investigation, when we move from one proposition to another through laws of logic, we go through emotions, stress and anxiety about getting the correct results, or uncertainties about our own competence, insurgence of fresh volitions to plunge into fresh arguments. These psychological states are invariably associated with our process of arguing. However Logic has to abstract its arguments from all these psychological accompaniments and present in a neat and clean shape.

1.6 LOGIC VERSUS ETHICS AND AESTHETICS

To have a more pointed grasp of the nature and scope of Logic we should further try to demarcate it from the other normative sciences like ethics and aesthetics. Ethics, like Logic and unlike Psychology, abstains from any description of facts. Ethics does not describe what people do, or how their psychological states occur in a causal chain. It is a study of how people *should* behave and accordingly tries to find out the norms to which human conduct should conform. For instance Ethics comes out with the norm (A) viz. everyone should act in a way that brings out maximum amount of happiness for the maximum number of people. Aesthetics comes up with

certain criteria of appreciating beauty, say a handwriting is said to be beautiful if the letters are evenly spaced, the writing line is used as the baseline, and the height of the ascending letters keep a definite proportion with the baseline. Now Logic does not strive to find norms for appreciating human conduct or standards for judging the beauty of an object. It is concerned with the validity of arguments, whether one proposition follows legitimately from another. Taking (A) to be true Logic will formulate norms for arriving at further propositions, without any reliance on any further norm of human conduct. In similar ways Logic would distance itself from Ethics.

Check Your Progress II

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

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

1. What is the similarity and difference between Logic and Ethics?

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1.7 THE DISTINCTION AND RELATION BETWEEN DEDUCTIVE LOGIC AND INDUCTIVE LOGIC

1.7.1 Limitations in the Method of Induction

The mutual distinction between these two approaches of Logic also determines the exact pattern of their inter-relation. Actually Deductive Logic has come to pervade the exact arena of Western Logic delimiting the scope of Logic in a particular way. One can say that certain lacunas of Inductive Logic have compelled a transition to Deductive Logic.

We have already noted that the general pattern of establishing general propositions by Inductive Logic or by Induction is as follows:

Man_1 is mortal.

Man_2 is mortal.

Man_3 is mortal.

…….

$Man_{10000000000}$ is mortal.

No instance to the contrary has been found so far.

· All men are mortal.

Inductive Logic also seeks to derive particular (not general) propositions about a particular object **a** as possessing certain features (B, C, D etc.) solely on the basis of another object **b** similar to **a**, possessing apparently the same features (B, C, D etc.) Such an argument-pattern dubbed as 'Arguments by Analogy' finds a typical example in the following narration:

There is a great similarity between Earth and the other planets like Saturn, Jupiter, Mars, Venus, etc. They all revolve around their own axis and light from the sun, many of them have moons and are subject to the laws of gravitation. Hence it is highly probable that these planets too are inhabited by living creatures as Earth is.

None of the two kinds of inductive arguments (Argument by enumeration of particular instances and Analogical Reasoning) are foolproof techniques. However as we have already noted, Inductive Logic is indeed equipped with more sophisticated methods for arriving at generalizations – say Mill's methods of Experimental Enquiry. Mill's Method of Difference prescribes the task of finding the sole circumstance in which the phenomenon under investigation (say malaria) would *differ* from cases where the disease does not occur. Further it also prescribes the method of finding a common pattern of variation among two phenomena –say increase or decrease of a certain kind of food-consumption and the frequency of a certain disease, or the ascending and descending degrees of molecular movement according with the varying intensity of heat.

Inductive Logic also charts out the criteria of forming good hypothesis, and upgrading them to the status of law. Such steps of scientific investigation will be –

1. Devising Preliminary Hypothesis (a conjecture about a disease being caused by an external infection, like an insect-bite)

2. Collecting Additional data
3. Formulating Explanatory Hypothesis
4. Testing the Consequences
5. Applying the Theory

Let us note that an Explanatory hypothesis, as contrasted with the Preliminary one, goes down to a deeper level of linking itself with the phenomenon under investigation. For instance applying heat upto 100 ^{0}C to water would be the *preliminary* hypothesis to explain the phenomenon of boiling, but going down to the molecular structure (H_2O composition) of water and linking this with the phenomenon of water showing bubbles on its surface (at 100 ^{0}C) will be an instance of formulating an *explanatory* hypothesis

Now let us come back to our previous worry about the limitations of Inductive Logic. However much a scientist dissects the composition of water he cannot deduce a unique boiling point from this composition. To afford such a deduction with absolute certainty the scientist needs to be equipped with the additional premise which may be stated as follows –

The standard descriptions of water, the applied heat and the atmospheric conditions, exhaust the entire content and identity of water and fire.

And this presupposition may well be false. Suppose there exists in addition to the known atoms of hydrogen and oxygen some unknown elements (viz. *x*) which remain unexplored in the atomic theory. In that case the entire substance familiarly known as 'water' and structured as 'H_2O'*plus* some bundles of *x* get into some complex kind of causal inter-relations. In other words it is perfectly possible that when we present the standard compositions of water and fire, we are only giving a partial description of these substances, and also that we are leaving out some elusive factors in our environment which may interact with water and fire to change the standard boiling point of water on future occasions.

So from the standard descriptions of water, heat, electricity, plus the known laws of physics, a scientist can only deduce that water will boil at 100 ^{0}C and no other temperature, *as long as there is no remainder in the structure of water and heat* and the surrounding light and air molecules, and no intractable interaction among these .

It is not a fact of pure logic or pure conceptual cum definitional connection that water has a unique boiling point at 100^0C. Similar remarks will apply to all men being mortal, Typhoid being curable by penicillin, or malaria being caused by anopheles. We cannot perform the above deductions in the way we can deduce Ram being mortal from all men being mortal and Ram being a man. Or the way we can deduce Ram being an unmarried man from Ram being a bachelor.

Thus Inductive Logic, with all its tools of sophistication can only *induce, incline* or *bend* us towards a particular conclusion. It can assure a high degree of probability, but not the full certainty.

1.7.2 Transition from Induction to Deduction

It is in this way that Deductive Logic intervenes and comes to cover the entire arena of Logic. The agenda of Deductive Logic is this – Provided that Inductive Logic supplies us with true propositions - say (i) Water having an H_2O structure will boil at 100^0C ,and that (ii) The liquid in Caspian Sea has an H_2O structure, then we can safely deduce (iii) This particular liquid in the Caspian Sea will boil at 100^0C. But whether the premises (i) and (ii) are true/false is not the task of Deductive Logic to ascertain.

It may seem that Deductive Logic undertakes the trivial operation of ceremoniously *deducing* certain propositions as *conclusions* – though they were already stated in the premises. However there are at least two significant and non-trivial tasks that Deductive Logic delivers:

1. It performs the task of extracting a conclusion – which although stated in the premises – is stated implicitly, in a camouflaged or obtuse manner

For instance take the following argument –

The Baron loves all who love Alma.

The Baron loves Alma

- The Baron loves himself.

The above argument, though valid, may not be obviously valid, for the simple reason that we often take the first premiss (viz. Baron loves all who love Alma) as excluding the Baron himself, presupposing that love is not the kind of relationship that a person can enter with himself. *Logic teaches us the lesson of freeing statements of their extra load of socially inculcated values and presumptions and trains us to take them in their stark, literal sense.*

2. Deductive Logic trains us not to be swayed away by familiar factual content of the premises and conclusion of the argument. It instructs us to concentrate not on the truth of the proposed conclusion in an isolated fashion, but whether that truth follows from the truth of the premises.

Take the following argument –

All women are bipeds

Khairee is not a woman.

- Khairee is not a biped

(Note: Khairee was a lioness brought up by a human family as their daughter since she was a cub - a fact not relevant for evaluating the validity of this argument).

Here all the premises as well as the conclusion are true, but the truth of the conclusion does not follow from the truth of the premises. While the class of women is included in the class of bipeds, the latter class may be more extensive to include beings that are not women, viz. birds. From the fact that Khairee is placed outside the class of women, we cannot deduce that Khairee is not a biped. That Khairee is a lioness is not informed to us in the above argument, and hence we cannot take that as a premiss.

While on the one hand Deductive Logic teaches us not to be swayed by the truth of the premisses, at the same time it also teaches us not be dissuaded by their falsity. One can construct innumerable valid arguments with false premises and a false conclusion.

Let us only take one such argument –

All women are three-legged

This lioness is a woman

- This lioness is three-legged.

It turns out that Deductive Logic deals only with the formal structure of arguments and not with their content. Western Formal Logic invites us to look upon all arguments pertaining to widely different subjects - physics, chemistry, biology, mathematics, sociology, psychology – only as certain formal arrangements of word-types. These word-types more or less correspond to the notion of parts of speech, a notion that we learned from our school-book grammar. Examples of these word-types will be:

i. Proper names or definite descriptions: 'Rajib', 'Mississippi', 'Mahabharata', 'the Grand Canyon', 'the present Prime Minister of India, 'this dream', 'this molecule', 'the square root of 4', etc.

ii. Common names or Predicate-words: man, mortal, state, river, atoms, quarks, metal, gas, dream, star, nerve, muscle, novel, metaphor, pain, itching, etc.

iii. Relational common names or relational predicate-words: loves, teaches, is jealous of, older than, is larger than, is adjacent to, etc.

One can easily appreciate how the above word-types can be used to form different propositions pertaining to different subjects. It is also easy to understand that apart from these variant proper names and predicates there will be some constant features across all arguments across all subjects.

iv. These will be quantifiers – 'All', None', Some', No', and various forms of the verb 'to be'.

Deductive Logic instructs us to identify these word-types or parts of speech and put specific symbols for each word-type, while keeping the quantifiers and verb-to-be intact. Hereby we can extract various forms of arguments – from which Deductive Logic goes on to identify which forms are valid and which are invalid.

1. All objects in motion move in a straight line

This is an object in motion

- This object will move in straight line

Putting S and P respectively for the subject and predicate of the conclusion, putting M for the third term figuring in the premises, and keeping the constants intact, we procure the following as a valid form

All M is P

This S is M

- This S is P

2. Nobody drinking half a litre of methylated spirit survives

That person drank that amount of spirit from a bottle.

- That person will die (will not survive)

No M is P

This S is M

- This S is not-P

3. All sensations are things that have local signs

All things having local signs can be measured

- Some things that can be measured are sensations.

All P is M

All M is S

- Some S is P

4. All planets are objects that obey the law of gravitation

Some celestial bodies do not obey the law of gravitation.

- Some celestial bodies are not planets.

All P is M

Some S is not M

- Some S is not P

We have identified four valid forms of argument – each of these arguments come from a specific area. 1 pertains to Physics. 2 pertains to Medicine, 3 pertains to Psychology and 4 belongs to Astronomy.

Exercise: Take each valid argument-form and fill it out by putting proper names and predicates for each symbol. Be careful that once you substitute specific terms for S, P and M in one proposition you must substitute the same term for the recurrence of S, P and M in the other propositions.

Substitute Form 1 by deriving the terms from Geometry. Thus you get a valid argument in Geometry.

Substitute Form 2 by deriving the terms from Biology. Thus you get a valid argument in Biology.

Substitute Form 3 by deriving the terms from Literature. Thus you get a valid argument in Literature.

Substitute Form 4 by deriving the terms from Sociology – thus getting a valid argument in Sociology.

(Do not bother about the truth/falsity of the propositions yielded)

The above exercise should convince us that Deductive Logic is subject-neutral or content-neutral, it is actually not about the world – whether it is the world of Physics, or the human body, or the socio-political life, or about the inner world of our sensations and emotions. *Deductive Logic is simply about the linguistic forms of statements to ensure that new statements can derived from given statements solely on the basis of given forms.*

Check Your Progress III

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

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

1. In what sense is Deductive Logic only formal?

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2. Why is Inductive Logic said to arrive only at probabilities and not certainties?

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1.8 HOW DOES WESTERN DEDUCTIVE LOGIC DIFFER FROM INDIAN LOGIC?

We see that Deductive Logic delinks the notion of validity from truth and also the process of inference from the product. Indian Logic by contrast does not adopt either of these methods of abstraction.

First, Indian Logic deals with the procedure of establishing a necessary connexion between the ground of inference (*hetu*) and the inferrable property (*sādhya*)

Secondly, it deals with the epistemological procedures of establishing the particular truths stated in the premises, viz. Ram being a man, or this liquid being water etc.

Thirdly it concerns itself with the order in which our cognitions occur stepwise – starting from the premises leading upto the conclusion.

For Deductive Logic on the other hand the ways of establishing the truth of the premises or the order in which the cognitions develop from the premises to the conclusion does not fall within its scope.

1.8.1 The wider notion of Inference in Indian Logic

Hence Indian logic uses the vocabulary – not of 'argument' but 'inference', which further ramifies into two sub-notions – of inferential cognition (*anumiti*) and the instrument or cause of inferential cognition (technically dubbed as *anumāna*) . This notion of inference (*anumāna* and *anumiti*) tracing the process through which one cognition finally gives rise to the conclusion is clearly a much richer notion than that of an 'argument' typically used in Deductive Logic. The latter abstracts not only from the content but also from cognitive phases through which the premises upgrade themselves to the conclusion.

That the Indian Logicians takes logic as a cognitive development gets manifest in the format of an inference typically used in the the *Nyāya* system.

a. Wherever there is smoke there is fire

b. This hill has fire

c. Smoke marked by the invariable presence of smoke is present in this hill.

d. ∴ This hill has fire.

Let us note that Western Deductive Logic will allow b to entail d straightforwardly without needing the further step of c. Nor is Deductive Logic interested in charting out the steps chronologically. However the *Nyāya* school of Indian Logic takes care to narrate that in any inference we *first* see a site characterised by a mark or a *hetu* – say a hill emitting smoke, *followed by* a remembrance of the universal co-presence of smoke and fire, further *followed* by the *assurance* that the smoke that we see comes under this universal rule. It is this *application of the universal to a particular instance* coming *last* in the series of cognition that immediately generates the *fina*l inferential cognition viz. 'The hill has fire'.

1.8.2 Illustrations of valid arguments in Indian Logic

(i) This particular place has no jar because it is not perceived – just as we perceive no flower growing in the sky - although the conditions of perception are fulfilled

(ii) The sounds of speech are impermanent entities because they are produced at will.

Whatsoever is produced at will is impermanent, e.g. a jar etc.

(iii) This is a tree because it is *Asoka*.

(The last three illustrations are taken from *Bauddha* school/Buddhist Logic).

(iv) Since the *krittikā* star is rising the *śakaṭa* star will rise a *muhūrta* (48 minutes) later.

(v) There is moon in the sky because there is reflection of the moon in water'

(vi) 'The sun is above because the earth is illuminated'.

(The last three illustrations are taken from *Jaina* logic.)

Let us note that all the above inferences are not in the same format – in some instances the main general premiss is suppressed. This is because for some schools of Indian Logic a person undertaking an inferential cognition for himself does not need to register the general premiss as a separate statement, though he needs it to demonstrate the inferential connection to a third person, or on a public platform. As Deductive Logic freezes the live process of inference into a timeless structure, devoid of any specific needs, interests or orientations of the subject, it is not sensitive to the possible variations in the layout of the inference in different contexts.

There are internal differences among various schools of the Indian logicians themselves, and yet they all agree in their common approach to Logic being about reality and not being merely about linguistic forms.

1.8.3 Fallacies in Indian Logic that pertain to Content

Besides Indian logicians also track down the possible ways in which an inference will incur a falsity in its premises and categorises that as a logical fallacy. Some examples of fallacious arguments owing to the *falsity* or other lapses in the *content* of the premises are cited below –

i. The hill has smoke because it has fire, and all loci of fire contain smoke.

(Note: Every locus of fire does not have smoke, hence the falsity of the general premise makes it an invalid inference. For Deductive Logic however, since the argument has a valid format viz. Form 1 specified in the last part of Sec 6. Hence it is valid, though *unsound* (due to the falsity of at least one of its premises.). Indian Logic is however committed to a more expansive notion of

validity that encompasses the notion of *soundness* i.e., factual content and truth of the premises and conclusion as well.

ii. Sound is eternal because it is an effect

(Note that no eternal thing can be generated as an effect, hence the very general statement serving as the required basis of this inference is false. This is also identified as a kind of fallacy in Indian Logic)

iii. Wherever there is a peacock's cry it is present

The cry comes from that cave (probably)

Therefore the peacock is present in that cave (probably).

Note that here we have correctly identified the species of the animal and connect it with its presence. There is nothing wrong in the first premise and even in thinking that a peacock is present in the vicinity. But here we lapse into an error in locating the exact place that the cry is coming from, which falsifies our second premise. This error in identifying whether a property belongs to a particular object or location incurs a fallacy in Indian Logic - though for Deductive Logic it is formally valid – exemplifying the same form as cited above.

iv. An atom is composed of parts because it has atomicity in it.

v. The fur on the turtle is a source for blanket, because it is soft etc.

(Note that iv is fallacious because the mark of atomicity being present only in atoms the inference does not afford any occasion to check whether this mark is concomitant with the inferable property in *other* loci as well.

v is invalid in a more unusual manner – for the very object (fur on the turtle) which is concluded to be the source of blanket is itself a non-entity. A proposition with a subject term that refers to nothing fails to be true/false and thus disturbs the issue of validity or invalidity of the argument. Again this argument being a substitution of the Form 1 is formally valid from the standpoint of Deductive Logic.)

The entirely formal or contentless character of Deductive Logic can be most pointedly registered in saying that none of the terms used in its arguments have any reference. The common names refer to a possible class, and the proper names like 'Ram' or even 'this atom' refers to possible particulars – just in the same fashion as '4' and 'triangle' refer to abstract concepts. Thus our patent generality viz. 'All men are mortal' merely means that there is no individual who is both a man and is non-mortal. And *if* there is an existent individual named as Ram *then* that individual has the predicate of mortality. Indian Logic on the other hand commits itself to real reference of each term used in the formulation of its valid inferences.

Check Your Progress IV

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

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

1. How is the approach of Indian Logic different from that of Deductive Logic?

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2. What is the difference between the notion of argument in Deductive Logic and inference as conceived in Indian Logic?

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1.9 THE RULE OF UNIVERSAL CONCOMITANCE (VYĀPTI) AS THE BASIS OF INFERENCE IN NYĀYA SCHOOL OF INDIAN LOGIC

In order to ensure that the inference is a correct one the *hetu* has to be universally and unexceptionally pervaded by the *sādhya*. This required relation between the *hetu* and *sādhya* is

called *vyāpti* or the rule of Concomitance. Here the qualification of the *vyāpti*-relation pertains to the *sādhya* – the *sādhya* must be such that it must never be absent where the *hetu* is present, (though the reverse might not always hold true). In our present example (Wherever there is smoke there is fire) fire is never absent in the locations of smoke, while the *hetu* or smoke is absent in some locations of fire (viz. the red hot iron ball) which shows that the *sādhya* is not pervaded by the *hetu*.

The suspicion of possible exceptions to *vyāpti* is to be overcome by a denial of the proposed rule, and this denial should entail a violation of the causal law. Such a procedure may be said to be an indirect argument or a *reduction ad absurdum* which takes the form: If smoke were not invariably pervaded by fire it would not have been produced by fire. But that fire causes smoke is an established law of Nature, and hence a counterfactual statement of there being smoke without fire as a possible exception to the rule would amount to a violation of the causal law.

1.10 DEDUCTIVE LOGIC: GROWING LEVELS OF COMPLEXITIES

It is because of its 'formal limitations' or formal purity that Deductive Logic reigns supreme in the arena of Logic. We shall wind up with an indication of how it develops its formal tools progressively to cope with arguments of newly emergent variations.

The most preliminary kind of Deductive Logic is Propositional Logic. This kind of logic is capable of dealing with a limited range of arguments - where a proof of their validity/invalidity depends on a layout of recurrent simple propositions contained in the argument – each simple proposition figuring as an ultimate unit of analysis. The proof of these arguments does not need one to get into the internal components of these simple propositions.

For example:

If this piece of litmus paper is put into acid it will turn red.

It has not turned red

- It is not put into acid

To evaluate this argument we need only to identify the simple propositions and put an abbreviated symbol or a propositional variable for each such proposition uniformly. Taking p, q, r as propositional variables we get the following form of the above argument.

If p then q

Not q

∴ Not p

More complex arguments can be handled by Propositional Logic -

If Communism generates Equality then people will go for it and if Capitalism creates more wealth CO_2 emission will increase.

.Either people will go for Communism or CO_2 emission will increase.

∴ Either Communism generates Equality or Capitalism creates more wealth

Following the same method of substitution we get the following form

If p then q and if r then s

Either r or s

∴ Either p or q

This however is an invalid form - for since both these consequents (of people going for Communism and increase of CO_2 emission) can occur in other ways, than the way stated by the antecedent propositions. To turn this into a valid argument we just need to reverse the order of the second premise and the conclusion. Overall we find that these kinds of arguments simply need us to identify the simple propositions and the propositional connectives like 'and' 'or', 'it is not the case that' etc. , and to do the necessary substitution in order to extract the logical form.

Now there are other arguments which will need us to analyse the simple propositions further into their internal components. Our patent argument viz. 'All men are mortal, Ram is a man, ∴ Ram is mortal' is an example of this kind. A scrutiny into Form 1 mentioned in Sec 6 will show how

this argument has been analysed into its constituent terms, and how these terms repeat themselves to shape up a valid argument-form.

The way arguments are analysed into subject-term (S), predicate-term (P) and middle term (M) was devised in the Aristotelian Logic. Deductive Logic in modern times, in the hands of Gottlob Frege and Bertrand Russell had taken a different style of analysis and symbolization. They have invoked two variables – one for individuals without general properties, and the other for properties floating freely of any individuals. The symbols chosen for individual variable are x, y, z etc. and those chosen for property variables are F and G.

Now in this style our good old argument will be symbolized as -

For all values of x if x is a F then x is G.

Ram is F

- Ram is G

Putting predicate constants for F and G we can get the original argument.

Frege and Russell have also prescribed the use of small letters a, b, c etc for the proper names like Ram, Mahabharata etc., and capital letters like H and M to abbreviate the predicate-constants like 'man' and 'mortal' respectively.

It is for this format of splitting the propositions into individual symbols and predicate-symbols that the Fregean method of logical symbolism came to be known as **Predicate Logic** as contrasted with Propositional Logic. It is also called **Quantificational logic** because this method of symbolism exhibits the *quantity* of individuals (*all*, s*ome* or a *single* individual) on which a predicate is applied. On the other hand the symbolism used in Propositional Logic did not have any scope or use for demonstrating the quantity of predication.

As arguments grow more complex – involving relational predicates (like 'teaches', 'loves', 'kills', 'is jealous of') the style of symbolism also has to get more and more incisive to make such arguments available to a method of testing or proof. This Logic comes to be termed as the **Logic of Relations.**

Arguments that seek to derive certain beliefs and desires of humans from certain other beliefs and desires will have to develop a different set of axioms, inference rules and symbolism. This kind of logic is known as **Intensional Logic**.

Arguments that seek to derive the necessity /possibility of certain propositions from those of given propositions need more tools and resources that are contrived in a higher kind of logic called **Modal Logic.** All these higher categories of logic develop by adding to the axioms, rules of inference, or the symbolic conventions already accepted in the simpler kinds of logic.

1.11 LET US SUM UP

Logic is a science that formulates tools for evaluating arguments as valid or invalid. It is broadly classified into Deductive Logic and Inductive Logic. Deductive Logic delinks the form of the argument from its content and truth-value of its constituent propositions. It also severs the product of argument from the actual cognitive process. Inductive Logic engages with both the content and form of its arguments - but is ultimately able to deduce statements only with a high degree of probability and not with the fullest certainty. Deductive Logic claims to deduce conclusions with the fullest certainty, but only at the cost of sacrificing the content of the real world. Indian Logic seeks to blend the formal validity of arguments with the necessary truth and real content of its premises and conclusion.

1.12 KEY WORDS

Anumāna: the instrument or cause of inferential cognition

Argument: It is a set of (at least two) propositions in which one or more propositions are claimed to be the ground of another proposition to be deduced.

Conclusion: The deduced proposition in an argument is called ‘conclusion’.

Deductive logic: It is based on deduction. In deductive reasoning the conclusion is certain and conclusive, because it is already implied by its premises.

Hetu: ground of inference.

Inductive logic: Inductive logic *induce, incline* or *bend* us towards a particular conclusion. In inductive reasoning the conclusion is probable.

Premise: The ground propositions in an argument is called 'premise/premiss.

Proposition: Propositions are meanings of indicative sentences.

Sādhya: inferrable property.

Vyāpti: the relation between the *hetu* and *sādhya*. It is an invariable relation.

1.13 FURTHER READINGS AND REFERENCES

- Copi I.M., and Cohen C, (ed) 2004, *Introduction to Logic,* Prentice Hall of India Pvt Ltd., Delhi.
- Copi, I.M., Cohen, C, McMohan K (ed) 2016, *Introduction to Logic*, Pearson, Delhi, Chennai. (for the chapter on Indian Logic)
- Hurley, P. (2014). *A Concise Introduction to Logic* (12th Revised edition), (Chapters 6, 7, 8), Wadsworth Publishing Co Inc.

1.14 ANSWERS TO CHECK YOUR PROGRESS

(Learners are advised to substantiate their answers by using their own illustrations and examples, wherever applicable.)

Check Your Progress I

1. **Hint:** Logic in its broadest sense deals with the *ways and norms* of observing facts and of gleaning information from the natural world. (Sec 1.3)

Check Your Progress II

1. **Hint:** Ethics is a normative study of how people should behave and accordingly tries to find out the norms to which human conduct should conform. (Sec 1.6)

Logic is a normative study of the rules governing the appraisal of arguments into good and bad; strong and weak.

Check Your Progress III

1. **Hint:** Deductive logic is merely concerned with the form and structure of an argument. (Sec. 1.7)

2. **Hint:** In inductive logic the conclusion is not already implied by premises, rather conclusion is only probabilistically suggested by the premises. (Sec. 1.7)

Check Your Progress IV

1. **Hint:** To establish the truth of the premises is not within the scope of deductive logic. Whereas Indian logic deals with the epistemological procedures of establishing the particular truths stated in the premises. (Sec. 1.8)

2. **Hint**: Deductive logic abstracts not only from the content but also from the cognitive phases through which the premises upgrade themselves to the conclusion.

(Sec. 1.8)