



BPYC-133

LOGIC



SCHOOL OF INTERDISCIPLINARY AND TRANS-DISCIPLINARY STUDIES (SOITS)

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NEW DELHI**

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COURSE INTRODUCTION

Logic (BPYC-133) is a six credit course meant for learners of BAG Philosophy. It is a core course, wherein the learners will become acquainted with the various aspects and concepts related to Logic. This course is comprised of 3 blocks and further divided into 14 units.

Humans are relational beings, who not just express their feelings and thoughts, but also communicate them with others. This need for communication and inter-action is founded upon the notions of relationality and shareability. We wish to and are able to communicate successfully, because we implicitly believe that the other has the capacity to understand what we express and we hope that the other would in fact understand our words, gestures and expressions. In a majority of situations, where humans interact and communicate, we aim at sharing not only our beliefs and desires, but also information which we have ourselves acquired from somewhere. In such cases, we make assertions and claims of the kind “This is so and so”. As a response to this claim, the other person may need and even demand a further justification for substantiating the veracity and correctness of the claim being made. The question then is not merely about how we know what we know, but how we can prove, justify, and ascertain its correctness. Most generally, the *set* of statements we make use of in order to prove or justify our claims can be called an “argument”. So, every time we are justifying a certain assertion or claim, we may say that we are constructing an argument in support of it.

Suppose, we were to claim that “X is mortal”.

And justify our claim with the following reasoning:

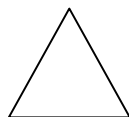
All humans are mortal.

X is a human.

Therefore, X is mortal (Our claim).

Let’s take another example:

Look at this figure →



With regard to this figure we may claim or assert that “This is a figure of a triangle” (Claim)

We may justify this claim with the following reasoning:

All figures whose inner angles sum up to 180 degrees are figures of triangles.

The angles of this figure sum up to 180 degrees.

Therefore, This is a figure of a triangle. (Claim)

It may be noted that our claims in these above examples can be deduced from the statements given to justify/prove the claim. The claim, along with the justificatory statements, is what formally constitutes an argument. Our claim can be identified as the “conclusion” and the statement(s) that are presented to justify our claim are identified as “premise(s)” of the argument. If the conclusion can be deduced from/implied by the premise(s), without a contradiction, then such an argument can be appraised as being a valid argument, otherwise if no such deduction can be made without falling into contradiction and inconsistency then the argument remains invalid.

Let us take another example similar to the 1st one above,

All humans are immortal.

X is human.

Therefore, X is immortal (our claim).

While we can see that this argument is valid, but the more important question concerns why this is so. Our argument is said to be valid when our claim/conclusion is implied by the given premises.

But there may be someone, who may hesitate in accepting our claim, because the very first premise stands in contradiction to ordinary experience, whereby we find that all humans are subject to birth and dying and are definitely not “immortal”. The first premise, “All humans are immortal.” is clearly *not* true, it is not telling us truly what is actually the case. In such a situation, the appraisal of our argument is further qualified by suggesting that though it is indeed valid, but it is not “sound”. That is to say, that though it is valid, but it is not giving us any information about the way the world in fact is or could possibly be like.

The above discussion allows us to understand how the very exercise of Logic is constituted by the study of the rules and methods that allow us to distinguish bad and good; proper and improper arguments; correct and incorrect reasoning.

Turning onto our first example again, we would find that the statement: “All humans are mortal” is a universal/generalized statement which aims at telling us something about *all* humans without any exception. It may however be asked how such a generalization is even possible, when all that we can ever be acquainted with are only some particular instances of individuals belonging to the human species; how are we even able to make a claim about unknown and yet unseen instances? There clearly appears to be a leap, which this “general” statement is making. Yet, despite the presence of this obvious jump, it needs to be noted that it is primarily through this kind of reasoning that our everyday assessments about objects, situations, individuals, as well as almost the whole of scientific knowledge and predictions have been advanced and developed. And interestingly, Logic also happens to be equally concerned with this kind of reasoning as well.

Further still, we would notice that the whole exercise of knowledge, i.e., wanting to know something is not only aimed at gathering information, but also aimed at achieving certainty and precision. Not only do we wish to know things, but we also want to know them with utmost certainty. But when we reflect upon the nature of language (the most evident medium of communication), we find that there is a possibility of hinderance in our quest of certain knowledge. While we aim at making our thoughts and communications as clear, unambiguous, and consistent as possible, language colors it with ambiguity and vagueness. We find that on the one hand there can be multiple meanings conveyed by the very same word, and on the other hand there can be a number of different words which render the very same meaning; in addition, accent too plays a major role in ambiguating communication. This ambiguity of meaning, together with our reliance on certain belief systems and social norms is what ends up (on many occasions) making our arguments fallacious, and hampering the overall quality of reasoning. In the course of the included units, the learner will also become conversant with the nature of fallacious reasoning, and the tools which can help us identify and thereby avoid such incorrect usage of arguments.

Summarily, therefore, the present course not only aims at introducing the learners to the domain of Logic; the foundational concepts; the relation between logic and language; fallacies in

argumentation; etc. but it will also acquaint them with the various modalities in which this exercise has been theorized about, including the developmental shift that took place from traditional to symbolic logical systems. We sincerely hope that this course will prove to be really helpful in equipping the learners to understand and point out the differences between correct and incorrect reasoning and argumentation.



Block 1

NATURE OF LOGIC

Block 1 “Nature of Logic” comprised of four units and deals with the definition of logic, a brief sketch of the history of its development, kinds of logic, the significance of, core concepts of logic, the difference between the approaches of Indian and western logic and so on.

Unit 1 “Introduction to Logic” introduces the basic theme of Logic, its subject-matter, nature and scope and the issues Logic primarily deals with. It gives an overview of the principal subdivisions within this subject, giving an indication about the *kinds* or *species* of Logic that gradually emerge from its broadest characterization or its genus. The key terms and concepts of Logic get addressed as common-sense notions embedded in our intuitive understanding of the subject. This unit also outlines the Indian approach to Logic and tries to present its difference with the western approach to logic.

Unit 2 “Basic Concepts in Logic” introduces the core concepts pertaining to the subject-matter of Logic. The notion of validity/invalidity, arguments, proposition, the distinction between sentence and proposition, the distinction between argument and argument-form, proposition and proposition-form etc. are the themes addressed in this unit. The main focus of this unit is on deductive logic. Indian logic has its own vocabulary. This unit also elucidates the vocabulary of Indian logic.

Unit 3 “Inductive and Deductive Logic” aims at familiarizing learners with the nature and scope of deductive logic (formal logic) and inductive logic (material logic). This unit will elaborate on the intricate features of these two types of logical reasoning. This unit highlights the role played by reasoning and inference in the development of Logic. This unit tries to present; the comparison between two types of the reasoning process, the distinction between universalization and generalization, different types of inductions.

Unit 4 “Truth and Validity” elaborates the concepts of Truth and Validity in Logic. This unit discusses; the meaning and importance of truth and validity in Logic, the relationship between truth and validity in Deductive Logic, the applicable similar concepts in Inductive Logic, the applicable similar concepts in Indian Logic.

UNIT 1 INTRODUCTION TO LOGIC*

Structure

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1.2 Definition of Logic – Argument and Proposition

1.3 Demarcating Logic from other descriptive sciences

1.4 Inductive Logic- Providing the basic tools of Scientific Inquiry

1.5 The Distinction between Logic and Psychology

1.6 Logic Versus Ethics and Aesthetics

1.7 The Distinction and Relation between Deductive Logic and Inductive Logic

1.8 How does Western Deductive Logic differ from Indian Logic?

1.9 The Rule of Universal Concomitance (Vyāpti) as the basis of Inference in Nyāya school of Indian Logic

1.10 Deductive Logic: Growing Levels of Complexities

1.11 Let Us Sum Up

1.12 Key Words

1.13 Further Readings and References

1.14 Answers to Check Your Progress

1.0 OBJECTIVES

The objectives of this unit are,

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- 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 of 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 catching 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:

Man₁ is mortal.

Man₂ is mortal.

Man₃ is mortal.

.....

Man₁₀₀₀₀₀₀₀₀₀₀ 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°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°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°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°C . 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°C , 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°C . 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:

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

- 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 *final* 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 CO₂ emission will increase.

.Either people will go for Communism or CO₂ 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 CO₂ 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*, *some* 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)

UNIT 2 BASIC CONCEPTS IN LOGIC*

Structure

2.0 Objectives

2.1 Introduction

2.2 Argument and its Constituents: Premisses and Conclusion

2.3 Argument and Inference

2.4 Proposition – Its Difference from a Sentence

2.5 Validity/invalidity of Arguments: Truth-Value of its Constituents

2.6 Sound and Unsound Arguments

2.7 Deductive and Inductive Arguments

2.8 Types of Propositions: Categorical and Conditional

2.9 Aristotelian Logic

2.10 Symbolic Logic Vs Aristotelian logic

2.11 Statement-Forms or Propositional Forms

2.12 Argument-Forms

2.13 Propositional Logic Vs Predicate Logic or Quantificational Logic

2.14 Difference between Aristotelian Logic and Predicate-Logic or Quantificational Logic

2.15 Formal proof of Validity

2.16 Fallacies

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2.17 Indian Logic

2.18 Let Us Sum Up

2.19 Key Words

2.20 Further Readings and References

2.21 Answers Check Your Progress

2.0 OBJECTIVES

This Unit introduces the core concepts pertaining to the subject-matter of Logic. We know that Logic is a science that deals with the norms or standards of evaluating arguments as valid/invalid. Arguments are made of propositions and propositions have to be carefully distinguished from sentences. In this unit learner will study,

- the distinction between arguments and argument-forms, propositions and proposition-forms.
- the notion of validity/invalidity of arguments as contrasted with the truth/falsity of its constituent propositions.
- the basic terms and concepts of Indian logic and its distinguishing features.

2.1 INTRODUCTION

We start with arguments – the principal target of logic - with an aim to appreciate its abstract and conceptual nature as distinguished from a concrete piece of inference. Discussion about the notion of an argument will naturally take us to the notion of propositions or statements, as distinguished from sentences, and further to the principal *kinds* and *forms* of propositions and also *forms* of arguments – as distinguished from their *content*. The idea of familiarizing ourselves with propositional forms and argument-forms is to appreciate the formal notion of validity and invalidity with which Deductive Logic is concerned. The extensive use of symbols that comes to mark modern ‘symbolic logic, and its basic difference from Aristotelian logic are issues that are woven with the theme of validity. The notions of formal proof of validity and formal fallacies in invalid arguments naturally come up in this context.

2.2 ARGUMENT AND ITS CONSTITUENTS: PREMISSES AND CONCLUSION

We know that 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. The ground propositions are called '**premisses**' and the deduced proposition is called '**conclusion**'. Premisses and conclusion are propositions that are the **constituents** of an argument.

Let us consider some examples of arguments:

(1) Rajiv is a first class M.A and Rahul is a PhD

∴ Rahul is a PhD.

(2) Either Anshu is a first class M.A. or a second class M.A.

Anshu is not a first class M.A.

∴ Anshu is a second class M.A.

(3) If Arun comes then Arati will also come.

If Arati comes then Indranil will also come.

If Indranil comes then Utpal will also come.

∴ If Arun comes then Utpal will also come.

(1) has **two** constituents, i.e., its conclusion is deduced from **one** premiss,

(2) has **three** constituents, i.e., its conclusion is deduced from **two** premisses.

(3) Has **four** constituents, i.e., its conclusion is deduced from **three** premisses.

2.3 ARGUMENTS AND INFERENCE

Inference is a cognitive process which addresses the sequence through which the knowledge of the premisses leads to that of the conclusion, coupled with the question whether the knowledge of the premisses is enough to lead to conclusion or whether other intermediaries are needed.

Argument on the other hand abstracts itself from the temporal sequence of an inference, and presents itself as a neat end-product, where the questions whether the premisses precede the conclusion, or whether some psychological procedure needs to intervene between the premisses and the conclusion are irrelevant. As Deductive Logic seeks to make arguments independent of cognition of the premisses, it also thereby makes the validity of arguments independent of the truth/falsity of the premisses. Thus an *argument in this sense seeks to represent merely the conceptual or hypothetical connection between the premisses and the conclusion – independent of the cognition of the premisses or their truth/falsity.*

2.4 PROPOSITION: ITS DIFFERENCE FROM A SENTENCE

Propositions are meanings of indicative sentences or statements made by the use 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.

Let us consider argument (2) Suppose the premisses are recast as -

Oh I wish either Anshu were a first class M.A. or were a second class M.A.!

Is Anshu not a first class M.A.?

I.e., we have turned each of the premisses into other non-indicative moods (a wish and a question).

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.

A better way to define propositions or statements is to say that *propositions are those which can be true/false, i.e., those which have truth-value.*

The Difference between Indicative Sentence and Proposition: It must be noted that indicative sentences are not constituents of an argument. Sentences - including indicative sentences - are physical objects consisting of visible signs or audible sounds. Consider the following sentences:

It is raining. (English)

Es Regnet. (German)

Il Pleut. (French)

वर्षा भवति। (Varṣā bhavati)- (Sanskrit)

All of these mean the same - or rather they make the same statement - but as sentences or as series of physical marks they are different. It is thus obvious that what enters into the constituents of arguments are the meanings of sentences, or statements made by indicative sentences – which are propositions.

Terms and Propositions: Propositions are often said to be composed of three terms – the subject-term, the predicate-term and the copula – which joins the former with the latter.

(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. Distinguish between Proposition and Sentence.

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2.5 VALIDITY/INVALIDITY OF ARGUMENTS: TRUTH-VALUE OF ITS CONSTITUENTS

While a proposition is either **true** or **false**, an argument is either **valid** or **invalid**.

A valid argument is such that if its premisses are true its conclusion cannot be false. This does not mean that a valid argument has to have true premisses. *What validity of an argument demands is that it cannot be a combination of true premisses and a false conclusion, though it may have other combinations like those of false premisses and true conclusion, or false premisses and false conclusion, etc.*

E.g. If Rabindranath Tagore won a gold medal in swimming in the Olympic Games, then he donated it to Vishwabharati.

Rabindranath Tagore won a gold medal in swimming in the Olympic Games.

∴ He donated it to Vishwabharati.

This is a valid argument, though its second premiss and the conclusion are false. The crucial point for its validity is that if its premisses were true the conclusion could not have been false.

An *invalid argument* is such that even if its premisses are true it may still have a false conclusion. This means that an invalid argument can have all sorts of combinations of the truth-values of its premisses and conclusion.

E.g. If Rabindranath Tagore was born in Gariahat then he was born in Calcutta. (**True**, because Gariahat is a place in Calcutta)

Rabindranath Tagore was born in Calcutta. (**True**)

∴ Rabindranath Tagore was born in Gariahat. (**False**, because he was born in Jorasanko, not Gariahat)

2.6 SOUND AND UNSOUND ARGUMENTS

An argument is sound when it is valid and all its premisses are true. Suppose we make small changes in the above invalid argument to recast it as –

If Rabindranath Tagore was born in Jorasanko then he was born in Calcutta. (**True**, because Jorasanko is a place in Calcutta)

Rabindranath Tagore was born in Jorasanko. (**True**)

∴ Rabindranath Tagore was born in Kolkata. (**True**)

Here we get a **sound** argument.

2.7 DEDUCTIVE AND INDUCTIVE ARGUMENTS

In a valid deductive argument the conclusion repeats what is implicitly stated by the **premisses**, and hence the conclusion is claimed to be absolutely certain. This property can be appreciated in all the examples of valid arguments illustrated above. On the other hand an inductive argument takes a leap beyond what is stated in the premisses and thereby claims only a degree of probability, and not certainty. A typical example of an inductive argument will be -

Man₁ is mortal.

Man₂ is mortal.

Man₃ is mortal.

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Man₁₀₀₀₀₀₀₀₀₀₀ is mortal.

No instance to the contrary has been found so far.

∴ All men are mortal.

2.8 TYPES OF PROPOSITIONS

If we look at the three arguments – (a), (b) and (c) cited above we see that they consist of two types of propositions – **simple** and **compound**. The propositions that are composed of the connective expressions like ‘and’ ‘or’ ‘if then’, are compound propositions and the propositions that are not compound are simple. So we can say-

The proposition which has at least one part that can itself be considered as a proposition is a compound proposition. To take one example from (2) Either Anshu is a first class M.A. or he is a

second class M.A. It is clearly a compound proposition because it has *at least* one part (in fact two) which can themselves be considered as propositions.

The proposition is said to be atomic or simple, when no part of it can be considered to be a proposition. The proposition viz. ‘Anshu is a second class M.A’ is an atomic proposition, for though it has many parts – viz. ‘Anshu’, ‘is’, ‘1st class’, etc. etc. , yet none of these parts itself amounts to a proposition.

Note that the proposition - ‘It is not the case that Anshu is intelligent’ - is also compound. Though it is not composed of two propositions connected by ‘or’ or ‘and’, still it fulfills the prescribed definition of compound proposition. It has a part viz. ‘Anshu is intelligent’ which itself is a proposition, and the entire proposition has to be deemed as compound.

From another point of view propositions can again be divided into two types – **categorical** and **conditional**. *Categorical propositions are those which make statements irrespective of any condition, whereas a conditional proposition makes a statement as qualified by some condition.* If I say - ‘The ground is wet’ – I am obviously predicating wetness of the ground irrespective of any condition; whereas , when I say – ‘The ground is wet provided it rains’ – I am introducing a conditional clause into this sentence and thereby making a conditional proposition. ‘All men are mortal’, ‘Ram is a man’ – both state categorical propositions. But the compound of all these three statements viz. ‘If all men are mortal and Ram is a man, then Ram is mortal’ will be a conditional proposition.

2.9 ARISTOTELIAN LOGIC

2.9.1 Fourfold Categorical Propositions

In Aristotle’s Logic categorical propositions were mainly conceived in terms of classes – which may be roughly symbolized as S and P – i.e., the subject-class and the predicate class. Accordingly Aristotle conceives categorical propositions as being of four types – depending on whether the propositions affirms a full or partial inclusion of one class into another, or whether it denies a partial or full inclusion of one class into another.

Categorical Propositions - Four types

(A) All S is P (**Universal Affirmative** – affirming full inclusion of S into P)

E.g. All mammals are warm-blooded

All creatures with hearts are creatures with kidneys

(E) No S is P (**Universal Negative** – denies a partial inclusion of S into P. This means that it affirms a full exclusion of S from P and vice versa.)

E.g. No girl is born out the genetic code of XY chromosomes.

No reptiles are quadrupeds

(I) Some S is P (**Partial Affirmative** - a part of S is included in the class P)

E.g. Some poets are novelists

Some reptiles are bipeds

(O) Some S is not P (**Partial Negative** - a part of the class S is excluded from P)

E.g. Some politicians are not honest

Some universities are not funded by UGC.

2.9.2 Conditional propositions

Conditional propositions are also divided into at least two types - Hypothetical and Disjunctive.

Hypothetical propositions are of the form **If p then q**– If the COVID 19 vaccine turns out to be effective in 2021 I shall travel abroad.

Disjunctive propositions are of the form - **Either p or q**: Either COVID 19 vaccine does not turn out to be successful in 2021 or I shall travel abroad.

2.9.3 Immediate and Mediate Inference

Immediate Inferences are those where the conclusion is claimed to follow from a single premiss.

All mammals are quadrupeds

∴ Some mammals are quadrupeds

All girls are born out XX genetic code

∴ Some beings not born out of XX genetic code of are not girls.

Mediate Inferences are those that have more than one premiss to entail the conclusion.

2.9.4 Mediate Inference: Syllogism and its Two types

Aristotle has a special term for two premised arguments – viz. **Syllogism**. Syllogisms will again be of two types - **Categorical Syllogism** and **Conditional Syllogism**.

Categorical Syllogisms will be those where all the constituent propositions – viz. the two premisses as well as the conclusion are categorical propositions.

Example (1) All girls are born out of the genetic code of XX chromosomes

No boys are born out of the genetic code of XY chromosomes.

∴ No boys are girls

Example (2)

No octopuses have kidneys like the humans

Some creatures with hearts have kidneys like humans.

∴ Some creatures with hearts are not octopuses.

Conditional Syllogisms will be those which have at least one conditional proposition as its premiss – that is either hypothetical or disjunctive.

If the COVID 19 vaccine turns out to be effective in 2021 I shall travel abroad.

I shall not travel abroad

∴ The COVID 19 vaccine did not turn out to be effective in 2021.

(Note: The first premise is hypothetical and the second premise is categorical. It is accordingly called a hypothetical syllogism.)

Example 2

Either the COVID 19 Vaccine fails to be effective or I shall take a world-tour.

The COVID 19 vaccine did not fail to be effective

∴ I shall take a world-tour.

(Note: The first premiss is disjunctive and the second premiss is categorical. It is accordingly called a disjunctive syllogism.)

Aristotle constructed a strong framework of Categorical Syllogisms – detailing out its possible forms – Moods and Figures, Rules and Fallacies. (Details about Categorical Syllogism will be discussed in Unit 3.) However he did not lay out a fully developed system of conditional syllogisms – hence discussion of Aristotelian syllogisms are mainly confined to categorical syllogisms.

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 difference between Mediate and Immediate inference?

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2.10 SYMBOLIC LOGIC VS ARISTOTELIAN LOGIC

Aristotle was considered to be the founder of Logic, hence the term ‘Aristotelian Logic’ is usually used to describe traditional logic. This logic has progressively become more sophisticated in its tools and extensive in its field and has come to be termed as ‘Symbolic Logic’. However there is no fundamental difference between Aristotelian Logic and Symbolic

Logic. Both genres of Logic have to use symbols, though the use of symbols came to be more and more extensive with the passage of time, and hence the name '**Symbolic Logic**' is conferred upon the Logic that we see in the present day.

2.10.1 What is a symbol?

Any sign, i.e., a written or spoken mark that is used to represent something is known as a symbol. There are two kinds of symbols – **word-symbols** and **non-word symbols**. 'Table', 'brown', 'walking' are all word-symbols, *rather each word of our ordinary language is a symbol.*

There are non-word symbols that are used in special sciences – like those in mathematics – viz. '1', '2', '—1', '+', '—', 'x', '%', '=', '>', etc. - which are used to represent numbers and various relationships amongst numbers. *Logic being a special science has to use special non-word symbols lay out its arguments and methods for proving them to be valid/invalid.*

2.10.2 Kinds of Symbols: Variable Symbols and Constant-Symbols

Logic uses these two kinds of symbols.

2.10.2.1 Variable Symbols

Variable symbols are certain place-markers that take in specific kinds of values in its space. We know that Logic deals mainly with propositions that go to constitute arguments. Propositions are further made of terms. So Logic initially needs to have at least two kinds of place-markers or variables - (i) **propositional variables** and (ii) **term-variables**.

(i) **Propositional variable** will take in atomic or **simple** propositions as its values. English consonants in small case like p, q, r etc. are used as propositional variables. Let us consider argument 3 to see how we can replace its constituent atomic propositions by propositional variables.

If Arun comes then Arati will also come.

If Arati comes then Indranil will also come.

If Indranil comes then Utpal will also come.

∴ If Arun comes then Utpal will also come.

It is obvious that each of the underlined expressions is an atomic proposition. By substituting each atomic proposition with a separate propositional variable the above argument turns out to be:

If p then q

If q then r

If r then s

∴ If p then s

Sometimes we need to get into the internal components of an atomic proposition, viz. to the terms. So here we need (ii) **term-variables** to symbolize an argument. Let us take the following term-variables like S (subject-term of the conclusion), P (predicate term of the conclusion) and M (middle term figuring in both the premisses) as term-variables to symbolize the following argument.

All teenagers are fun-loving

All School-children are teenagers

∴ All school children are fun loving.

All M is P

All S is M

All S is P

2.10.2.2 Constant-Symbols

Constants unlike variables are not place-markers, they do not take in values, thus the **constant symbols** of Logic serve to abbreviate the symbols that we already use in our ordinary or natural languages – like English, Bengali, Hindi etc. Note that the propositions and the propositional

connectives that we use in our ordinary language are all constants, simply in the sense that they are not place-markers to take values. Let us focus on how Logic abbreviates these two kinds of constants, viz. the (i) **propositional constants** and the (ii) **propositional connective constants**

(i) Propositional Constants: First let us how logic turns the simple propositional constants into abbreviations like P, Q, R. Thus if we take argument 3 again, then using English alphabets P, Q, R, S etc. - each alphabet consistently for each atomic proposition - we get :

(A)

If P then Q

If Q then R

If R then S

∴ If P then S.

Thus we have got an abbreviation of the argument 3. Note the difference between (A) and the following -

(B)

If p then q

If q then r

If r then s

∴ If p then s.

(A) is an **abbreviation** of the argument (3) while the (B) represents the **form** of (3). From (A) you will only get the unique unabbreviated argument (3), while from (B) you can get many arguments of the same form. This is for the simple reason that for 'p', 'q', 'r', and 's' you can substitute many other atomic propositions like - It is raining, Rajendra Prasad was the President of India, Rajiv is dreaming etc., and get different arguments. But P, Q R, being specific abbreviations for specific propositions, the question of substitution does not arise.

To repeat: **(A) is an argument** (written in an abbreviated form) and (B) is an **argument-form**, not an argument (whether abbreviated or unabbreviated)

Further note: **‘If p then q’ – is not a proposition, but simply a propositional form** (like ‘If ____ then ____’), and it does not have a truth-value.

‘If P then Q’ - is a proposition (abbreviated) and it has a truth-value.

To repeat: ‘P’ and ‘Indranil comes’ are **propositional constants**. But ‘p’ ‘q’, ‘r’ etc are **propositional variables**.

Thus symbols that Logic uses for abbreviating propositional constants are explained.

10.2.3 Connective Constants and Logical Constants

Let us look into how Logic uses symbols for abbreviating other kinds of constants in language, which are *not* propositional constants. These other kinds of constants are **propositional connectives** - ‘and’, ‘either or’, ‘if then’, ‘if and only if’, ‘it is not the case that’. Apart from these propositional connectives there are quantifiers like ‘All’, ‘Some’, ‘Few’, ‘A few’ etc.

*The connectives and quantifiers are also called **Logical constants**, because they are the constant features of all language and all disciplines on which Logic can operate in a language-neutral and subject-neutral manner.* Though these ordinary language expressions are already short and wieldy, yet Logic uses further abbreviations, or a special set of symbols instead of these constants. Thus Logic uses -

‘.’ for ‘and’

‘v’ for ‘either or’

‘ $\supset$ ’ for ‘if then’,

$\equiv$ for ‘if and only if’,

‘ $\sim$ ’ for ‘it is not the case that’

Now the forms of arguments (2) and (3) can be respectively symbolised as –

(2) $p \vee q$

$\sim p$

$\therefore q$

and

(3) $p \supset q$

$q \supset r$

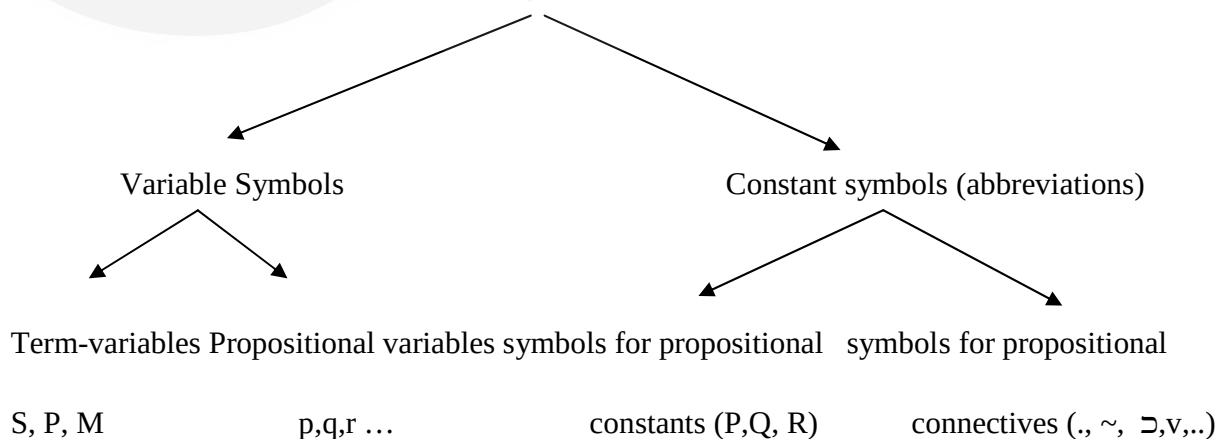
$r \supset s$

$\therefore p \supset s$.

We shall see that as Logic advances it has to use more and more special symbols for other kinds of constants as well – viz. for quantifiers, for predicate-terms as distinguished from subject-terms. The picture about Symbolic Logic that has emerged so far can be given in the following section.

10.2.4 Chart of Symbols used in Logic

Symbols used in Logic



Please note that Aristotle, the founding father of Logic was also the first person to use variable symbols , viz. term-variables like S,P,M etc. and also propositional variables to a certain extent. *However he never used symbols for propositional connectives or for quantifiers.* Hence modern ‘**Symbolic Logic**’ earns its name mainly from its extensive use of symbols.

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. Distinguish between Variable symbol and Constant symbols.

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2.11 STATEMENT-FORMS OR PROPOSITIONAL FORMS

Once we understand the distinction between a propositional variable and a propositional constant it is easy to understand what a propositional form is. **Propositional form** is a sequence of symbols which only contains propositional variables and no propositions (not even the abbreviations of propositions) so that when simple propositions are consistently substituted for each propositional variable, the result is a proposition. Thus p , $\sim p$, $p \vee q$, $p \supset q$, etc. are all propositional forms.

There are three broad propositional forms – **Tautologous, Contradictory and Contingent.**

A propositional form is **tautologous** when whatever propositions are substituted as values of the propositional variables - the resultant proposition will always come true. Forms like $p \vee \sim p$, $(p \supset q) \supset q$ are relevant illustrations.

A propositional form is **contradictory** when whatever propositions are substituted as values of the propositional variables - the resultant proposition will always come out to be false. Forms like $p \cdot \sim p$, $(p \cdot (p \supset q)) \cdot \sim q$ are relevant illustrations. All propositions other than these kinds of

two forms - say - $p \cdot q$, $\sim p$, $p \supset q$ etc. are contingent, which means that their substitution-instances sometimes turn out to be true, sometimes false.

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. Distinguish among Tautologous, Contradictory and Contingent logical forms.

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2.12 ARGUMENT-FORMS

Argument-forms are a sequence of symbols containing logical constants and propositional variables, but no propositions, so that consistent substitution of simple propositions for each propositional variable results in an argument.

(Exercise: Apply this definition to $p \supset q$, $q \supset r$, $r \supset s$: $p \supset s$.)

2.13 PROPOSITIONAL LOGIC VERSUS PREDICATE LOGIC OR QUANTIFICATIONAL LOGIC

Logic has to analyse arguments to display their characteristic forms of validity. Propositional Logic is confined to a special range of arguments, viz. those that do not need us to go beyond the simple propositions and lay out structure in which their component terms are arranged. Thus for propositional logic the ultimate terminus of analysis are simple or atomic propositions. Taking a look at the arguments used so far we can easily appreciate that demonstrating their validity needs some elements of the premisses to be repeated in the conclusion. For instance the way in which arguments 1, 2 and 3 become valid needs certain atomic propositions in the premisses to be repeated in the conclusion - in their entirety. This we have noted with respect to the form of argument 3.

On the contrary look at this argument:

All teenagers are fun-loving

All Schoolchildren are teenagers

∴ All school children are fun loving

All the constituent propositions of this argument are atomic propositions in the sense that no part of these propositions is itself a proposition. To display the validity of this argument we need to show how the internal components or terms of each of these propositions are configured, and which terms re-appear in the conclusion. And for this we need to display the form of this argument by virtue of replacing each term by a term-variable - like S, P, and M. Thus comes up a different genre of Logic – viz. **Predicate logic** – which, in order to prove arguments to be valid or invalid has to split each atomic proposition into its constituent subject-term and predicate-term and also the quantifier like ‘All’ or ‘Some’. Thus **Predicate Logic** is also termed as **Quantificational Logic**. **Propositional** logic, with its propositional mode of analysis, cannot display the **Quantity of a proposition – viz. whether the proposition states its predicate for all or some individuals**. Predicate logic with its sharper tools of analysis into the internal components of an atomic proposition is able to perform that task.

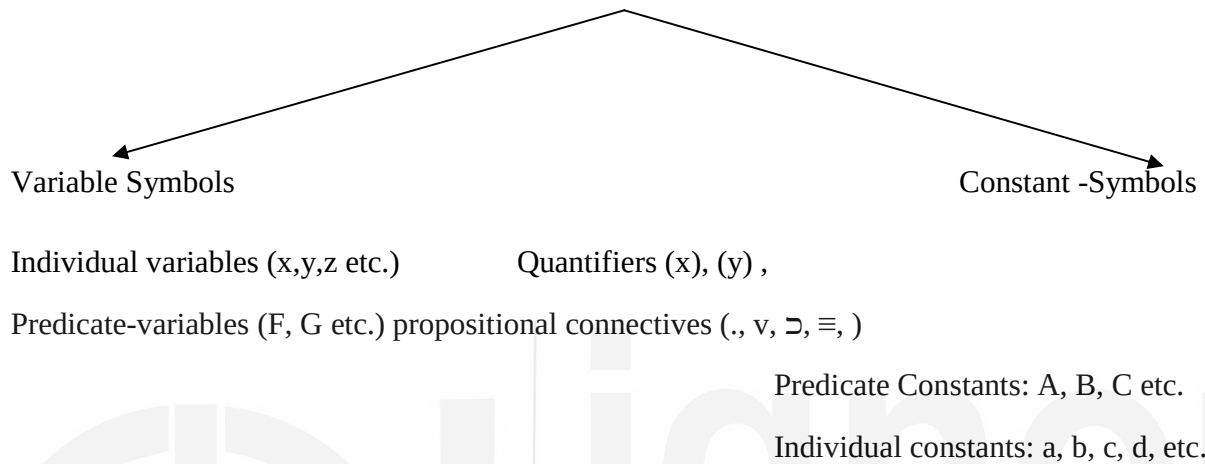
2.14 DIFFERENCE BETWEEN ARISTOTELIAN LOGIC AND PREDICATE-LOGIC OR QUANTIFICATIONAL LOGIC

Now although we can say that Aristotle’s syllogism falls within the subject-matter of Predicate-logic or Quantificational Logic, there are at least two important reasons due to which Aristotelian Logic cannot be identified with **Predicate logic** or **Quantificational logic**.

Firstly, the latter uses a different mode of analysis than the Aristotelian model of division into S, P and M. This Logic invokes two variables – one for individuals without general properties, and the other for properties independent of any individuals. The symbols chosen for individual variable are x, y, z etc. and those chosen for property variables are F and G. Further symbols stipulated for abbreviating individual constants and predicate-constants are English alphabets – a, b, c etc., in the small case and in the capital case respectively. Thus **Predicate Logic** operates

with an exclusive disjunction between subject (pure individual) and predicate (pure property) and hence significantly differs from **Aristotelian Logic**.

Symbols Used in Predicate-Logic or Quantificational Logic



Secondly, Aristotelian mode of putting both a singular proposition (Ram is mortal) and a general proposition (All men are mortal) under an A proposition glosses over their mutual distinction. As **Predicate Logic** brings forth a finer dimension of quantity, viz. the quantitative distinction between an individual and general mode of predication, its alternative name of **Quantificational Logic** connotes a difference from the Aristotelian Logic.

2.15 FORMAL PROOF OF VALIDITY

It is clear that the task of Deductive Logic or Formal Logic is to improvise rules of inference by which it can move from one statement to another by the sheer formal power of these statements and not by their content. For example there must be a rule of conjunction by which we can move from $p \cdot q$ to q , there must be a rule of negation, conjunction and disjunction by which we can move from $\sim(p \cdot q)$ to $(\sim p \vee \sim q)$, there must be a rule of implication which allows us to move from $p \supset q$ and p , to q . Hence we can formulate the definition of the term '**formal proof of validity**' as – *a sequence of statements, each of which is either a premiss of a given argument, or follows from the preceding statements of the sequence by one of the rules of inference, where the last statement in the sequence is the conclusion of the argument whose validity is proved.*

Check Your Progress V

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 does Propositional Logic differ from Predicate Logic or Quantificational Logic?

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2. How is Aristotelian Logic different from Predicate Logic or Quantificational Logic?

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2.16 FALLACIES

With each form of a valid argument there will be a corresponding form of invalidity. E.g. corresponding to the valid form viz. $(p \supset q) \cdot p \therefore q$ there will be an invalid form viz. $(p \supset q) \cdot q \therefore p$. Formal fallacies would be flaws that one would incur in moving from one proposition to another on the basis of an invalid argument form or an invalid rule of inference. Thus affirming the antecedent on the basis of affirming the consequent is a kind of fallacy.

2.17 INDIAN LOGIC

Indian Logic does not only deal with the rules of evaluating arguments, but also with the rules of attaining valid cognition of the premisses. Thus it is concerned with the full fledged cognitive process of inference and not simply the bare formal structure. Thus Indian Logic does not make the distinction between induction and deduction, or between form or content of arguments

2.17.1 Anumāna and Anumiti

Both *Anumāna* and *Anumiti* pertain to the cognitive process of inference. The special means employed for attaining as inferential cognition is called *anumāna*. The cognition that results from the employment of the special means is called *anumiti*.

2.17.2 Constituents of an Anumāna: Hetu, Sādhya, and Pakṣa

In an inference there is always an entity of which something is predicated on the strength of some other thing.

The entity of which something is predicated is called the subject or pakṣa.

The something that is predicated of the pakṣa is called the probandum or the sādhya.

The thing on the strength on which the predication is performed is known is called the probans or mark or hetu of the inference.

The stock example of an *anumiti* is - This hill has fire, because wherever there is smoke there is fire, and this hill has smoke that is pervaded by fire. Evidently what figures as the pakṣa, sādhya and hetu in the above example are the hill, the fire and the smoke respectively. (One can also easily see that they roughly correspond to what is signified by the minor term, major term and the middle term of the western syllogism.)

2.17.3 Anumāna or Parāmarśa

The special means or the *anumāna* for acquiring *anumiti* is a special kind of cognition viz. **Parāmarśa**. Roughly speaking, in any inference we 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 assurance that is the *parāmarśa*. *To it more formally, it is the cognition of the subject (pakṣa) of an inference, having a mark (hetu) that in its turn is universally pervaded by the sādhya or the property to be inferred.* This *parāmarśa* or application comes last in the series of cognitions, immediately generating the final inferential cognition viz. ‘The hill has fire’; and hence it is called the instrumental cause of inferential cognition.

2.17.4 Svārthanumāna and Parārthanumāna

Inferences are generally of two types – *inference for oneself (svārthānumāna)* and inference for others (*parārthānumāna*). The above account applies to the first kind, where a person applies a *hetu* in a particular site to gain some new knowledge for his own purpose (*svārtha*). On the other hand the person may also adopt a special means to bring about an inferential cognition for others (*parārtha*).

2.17.5 Parārthānumāna or the Five Membered Syllogism

On the occasions of *parārthānumāna* the speaker employs a compound statement consisting of five components to produce the required inferential cognition for his hearer. For the stock example of inference from smoke to fire these five statements will be:

- (i) There is fire in the hill, (*Pratijñā* or Thesis)
- (ii) Because there is smoke (*Hetu* or the Reason)
- (iii) Wherever there is smoke there is fire (as in kitchen etc.) (*Udāharaṇa* or the statement of *vyāpti* with examples)
- (iv) The hill has smoke which is pervaded by fire (*Upanaya* or Application)
- (v) Therefore the hill has fire (*Nigamana* or Conclusion)

The Naiyāyikas hold that it is the cognition generated by this five-membered statement in the form of a *parāmarśa* that is the penultimate stage in generating the inferential cognition in the mind of the hearer, and hence that *parāmarśa* again is the *parārthānumāna* in the primary sense of the term.

2.17.6 Vyāpti

In order to ensure that the inference is a correct one the *hetu* employed has to be valid. To be valid, the *hetu* has to be universally and unexceptionally pervaded by the *sādhya*, so that one can legitimately say: ‘Wherever there is *hetu* there is 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.) 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*.

2.17.7 Hetvābhāsa

The term ‘hetvābhāsa’ is a compound of two terms: ‘hetu’ and ‘ābhāsa’ i.e. the appearance or a fault. The term ‘hetvābhāsa’ thus stands for an apparent or seeming mark, or the folly of the proposed mark. ‘Hetvābhāsa’ is defined as *that whose correct cognition is an impediment to an inference*.

Example: Sādharaṇa Savyabhicāra is a type of Hetvābhāsa. A faulty *hetu* of this type is defined as one which is present where the *sādhya* is absent.

For instance: This hill has fire

Because it is knowable

Here hill is the *pakṣa*, fire is the *sādhya*, and knowability is the *hetu*. The *hetu* is not only present in the items like kitchen, cowshed, factory, where the *sādhya* is present, but also in the sites where the *sādhya* is absent - like lakes, ponds, ice-refrigerator etc. The *hetu* is not present exclusively where the *sādhya* is, and thus impedes the correct cognition of *vyāpti* between knowability and firehood.

Check Your Progress VI

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

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

1. Distinguish between Svārthānumāna and Parārthānumāna in Nyaya Logic.

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2.18 LET US SUM UP

Focusing on the notion of arguments and the propositions that constitute arguments we have browsed through all the basic notion of deductive logic. The use of symbols designed to uphold the logical form of propositions and arguments, furnishing a key to the techniques of applying formal proofs of validity have been clarified. Lastly the basic notions and vocabulary of Indian Logic have also been presented – to provide a more comprehensive grasp of Logic.

2.19 KEY WORDS

Argument-Form: is a sequence of symbols containing logical constants and propositional variables, but no propositions, so that consistent substitution of simple propositions for each propositional variable results in an argument.

Categorical propositions: are those which make statements irrespective of any condition.

Conditional proposition: makes a statement as qualified by some condition.

Formal Proof: a sequence of statements, each of which is either a premiss of a given argument, or follows from the preceding statements of the sequence by one of the rules of inference, where the last statement in the sequence is the conclusion of the argument whose validity is proved.

Hetvābhasa: an apparent or seeming mark, or the folly of the proposed mark.

Immediate Inferences: are those where the conclusion is claimed to follow from a single premiss.

Inference: Inference is a cognitive process which addresses the sequence through which the knowledge of the premisses leads to that of the conclusion.

Mediate Inferences: are those that have more than one premiss to entail the conclusion.

Parāmarśa: the assurance that the *hetu* that we see comes under *vyāpti*.

Propositional form: is a sequence of symbols which only contains propositional variables and no propositions (not even the abbreviations of propositions) so that when simple propositions are consistently substituted for each propositional variable, the result is a proposition.

2.20 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.

2.21 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-** sentences are not constituents of an argument, whereas propositions are the constituents of an argument; Sentences are physical objects consisting of visible signs or audible sounds; Meanings of declarative sentences enter into the constituents of arguments. (Sec. 2.4)

Check Your Progress II

1. **Hint-** Immediate Inferences are those where the conclusion is claimed to follow from a single premiss.

Mediate Inferences are those that have more than one premiss to entail the conclusion.

(Sec. 2.9.4)

Check Your Progress III

1. **Hint-** Variable symbols are certain place-markers that take in specific kinds of values in its space.

Constants unlike variables are not place-markers, they do not take in values.

(Sec. 2.10.2)

Check Your Progress IV

1. **Hint:** In a Tautologous propositional form all instances of the resultant proposition turn out to be true.

In a contradictory propositional form all instances of the resultant proposition turn out to be false.

In a contingent Propositional form some instances of the resultant proposition turn out to be true and some instances of the resultant proposition turn out to be false. (Sec. 2.11)

Check Your Progress V

1. **Hint:** Propositional logic cannot display the Quantity of a proposition, whereas Predicate logic is able to perform that task. (Sec. 2.13)

2. **Hint:** Predicate logic uses a different mode of analysis than the Aristotelian model of division into S, P and M.

Aristotelian mode of putting both a singular proposition and a general proposition under an “A” proposition glosses over their mutual distinction.

(Sec. 2.14)

Check Your Progress VI

1. **Hint:** inference for oneself (svārthānumāna) and inference for others (parārthānumāna).

On the occasions of *parārthānumāna* the speaker employs a compound statement consisting of five components to produce the required inferential cognition for his hearer.

(Sec. 2.17.4 and 2.17.5)

UNIT-3 INDUCTIVE AND DEDUCTIVE LOGIC*

Structure

- 3.0 Objectives
- 3.1 Introduction
- 3.2 Deductive reasoning
- 3.3 Inductive reasoning
- 3.4 Relation between two types of reasoning
- 3.5 Arguments against deductive and inductive reasoning
- 3.6 Types of inductive argument
- 3.7 Indian Logicians' view on types of reasoning
- 3.8 Let Us Sum Up
- 3.9 Key Words
- 3.10 Further Readings and References
- 3.11 Answers to Check Your Progress

3.0 OBJECTIVES

This unit titled *Inductive and Deductive Logic* aims at familiarizing you with nature and scope of deductive logic (formal logic) and inductive logic (material logic). Logic, traditionally, has been divided into two types; deductive and inductive. This unit will elaborate on intricate features of these two types of logical reasoning. By the end of this unit you will learn:

- The role played by reasoning and inference in the development of logic.

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- The distinction and connection between two types of reasoning process.
- Distinction between universalization and generalization.
- Different types of inductions.

3.1 INTRODUCTION

Logic is the science of reasoning. Logic as a discipline trains a person in certain methods, devices, tools and techniques that help in differentiating right reasoning from wrong ones. Reason/Reasoning is used to form inferences; conclusions drawn from propositions or assumptions that are supposed to be true. A piece of reasoning involves argument that is a relational arrangement of premises (evidences, facts, assumptions) and conclusion. As there are more than one ways to start with information and arrive at a conclusion; thus, there are more than one ways to reason. Each has its own strengths, weaknesses, and applicability to the real world. Depending on the type of logical relationship (probable or necessary) between premises and conclusion, there are two forms of reasoning- inductive and deductive and corresponding two types of logic. Inductive logic deals with inductive arguments and deductive logic deals with deductive arguments. Though the nature of reasoning in both of them is not same, their aim is same. Both inductive and deductive logic provide methods and criterion to differentiate correct reasoning from incorrect ones. Deductive reasoning is the process in which conclusions are drawn with logical certainty from given premises. This type of reasoning is used in mathematical proofs or when dealing with formal systems.

In inductive reasoning one draws the “best” conclusion suggested by the set of observations/ experiential statements. Here observations used as evidence are always incomplete and insufficient to support a definitive conclusion, therefore one can never be certain of the conclusions one makes. This process is analogous to the scientific process in general. From the above discussion it can be observed that logic is a discipline of study to learn how to reason well. Meanwhile, reasoning is the mental process used to draw inferences from certain assumptions, beliefs, facts or observations; and arguments are the structural arrangement of content of thought process (premises and conclusion). Due to this intimate connection of meanings, one may find, these terms *logic*, *inference*, *argument* and *reasoning* are quite often used interchangeably while explaining induction and deduction. To understand the nature and scope of inductive and

deductive logic, we shall now look at the intricate features of two forms of reasoning at length in the following sections.

3.2 DEDUCTIVE REASONING

In deductive reasoning the relation between premises and conclusion is of necessity i.e. conclusion necessarily follows from premises. In other words, premises offer *conclusive ground* for conclusion. *Conclusive ground* means evidences are complete and sufficient enough to support the conclusion. Acceptance of premises leaves no room for any reasonable or meaningful doubt about acceptance of conclusion.

Let us take an example:

Argument 1: P1: All men are mortal

P2: Mahatma Gandhi is a man

C: Therefore, Mahatma Gandhi is mortal

The conclusion “Mahatma Gandhi is mortal” is already contained in the premises. What is already contained in the premises in implicit form, reasoning just makes it explicit in conclusion. There is no novelty. No new information is given in the conclusion. So, in any valid deductive argument it can never be the case that false conclusion is drawn from all true premises. If we have assumed something to be *true* in premises, how can it be opposite i.e. *false* in conclusion? It is a contradiction in itself. In deductive reasoning, we don't go beyond what is stated in the set of premises.

Deductive Reasoning provides necessary and certain knowledge: One may even wonder that if the conclusion does not go beyond premises and no new information is acquired in the process, then what the significance of deductive arguments is. This curiosity finds its answer in understanding the point that *knowledge is not mere acquisition of new information*. Knowledge is the outcome of critical, reflective and analytical attitude. There is an ancient Indian saying: *eliminate ignorance (avidya) and become enlightened*. Deductive argument helps us to know what is imbedded in the premises. It is an expedition into the analysis of the meaning of the premises. We analyze and reflect on the information provided in the premises and form

connections between different aspects. And then what's already there in implicit form, stated out in conclusion explicitly. We can comprehend now, why the denial of conclusion in such a case amounts to denying the meaning of the premises which were accepted earlier. Therefore, we say that a valid deductive argument is characterized by logical necessity. An argument is valid if its premises necessarily imply its conclusion, otherwise it becomes invalid. In a valid deductive argument, conclusion is either equal to the premises or less than them, but never states anything which goes beyond or wider than information given in premises.

Moreover, addition of more information to premises does not affect the conclusion of valid deductive argument. In the above cited argument any further addition to the already given set of premises, for instance adding "Mahatma Gandhi preached Non-violence and Truth", "Mahatma Gandhi was the author of Hind Swaraj" etc. makes no difference to the conclusion. Given set of premises (P1 and P2) in the above argument are complete, sufficient, proper to entail conclusion (C). A valid argument cannot become more valid in virtue of addition of one or more premises. On the other hand, if any one or more premises are taken out of a valid argument, then the argument does not become 'less valid', it simply becomes 'invalid'. Subtraction of premise from argument changes the status of argument straight away from valid to invalid. So, a deductive argument is either valid or invalid. Validity is not a matter of degree. Differences between valid and invalid arguments are only in kind. 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.

Formal character of the deductive argument: One of the significant features of deductive logic is its formal character. It puts emphasis upon the structure and form of an argument. Form or structure of the argument is order, pattern, arrangement in which all the elements (terms and propositions) stand in relation to one another. Form is the only deciding factor in assessing the validity/invalidity of deductive arguments. In inductive logic matter or content is of primary importance. When we deal with the form of deductive argument, we also deal with 'validity' and 'invalidity', on the one hand, and 'truth' and 'falsity' on the other. Only propositions are evaluated as true or false whereas deductive arguments are evaluated as valid or invalid.

We generally think that a combination of true statements will lead to valid argument and false to invalid, but this is not the case. It means that truth and validity may or may not coincide with

each other. Structure of the argument plays an important role in deciding validity and invalidity of argument. There is a distinction between material truth and logical truth. Material truth is what is stated by matter of fact. Logical truth is the outcome of the form of argument. A deductive logician does not question the status of premises. It does not matter to him or bother him if the premises are actually true or not. He merely checks what necessarily follows from the given set of premises. He does not do empirical enquiry. In deductive reasoning one assumes premises to be true (irrespective of their actual/material truth value) and then arranges them in such a manner that conclusion necessarily follows from them.

All possible combinations of the connection between truth- falsity of the statements of the argument and validity- invalidity of that argument can be summarized as shown in the table below. (Reason with examples for each case shall be explained at length in the next unit *Truth and Validity*. It has been discussed here in brief to make you appreciate and comprehend the formal nature of deductive reasoning.)

	Premises	Conclusion	Arguments
1	TRUE	TRUE	VALID
2	TRUE	TRUE	INVALID
3	TRUE	FALSE	INVALID
4	FALSE	TRUE	VALID
5	FALSE	TRUE	INVALID
6	FALSE	FALSE	VALID
7	FALSE	FALSE	INVALID

Table 1: Relation between Truth and Validity

Through this table we can observe that:

- A valid argument (1, 4 and 6) may consist of a true premise with true conclusion (1) or false premise with false conclusion (6) or false premise and true conclusion (4).
- An invalid argument (2, 5 and 7), similarly, may consist of statements in exactly the same manner as mentioned above. It may consist of a true premise with true conclusion (2) or false premise with false conclusion (7) or false premise and true conclusion (5).

- c) Case-3 points out towards the logical necessity associated with deductive reasoning. In any valid deductive argument false conclusions cannot be drawn from all true premises. In this case, necessity is of a particular kind, i.e. logical necessity. We have already mentioned this point in previous paragraphs as a significant aspect of deductive reasoning. An argument is called sound if it is valid and the premises are materially true.

From the above combinations it is clear that even with all false propositions one can give a valid argument and with all true propositions an invalid argument. The point to note here is that validity and invalidity are formal notions and hence applied to formal reasoning or formal logic only.

Deductive logic like mathematics is a formal science. The arguments in deductive or formal logic are categorized into different classes according to the general form/structure they possess. Arguments having the same form are treated in the same manner even if the content of each argument is different. The logicians search for formal similarity among the arguments. For example, argument 2 and argument 3 given below have the same form though the content is different.

Argument 2

P1: All Mathematicians are Logicians.

All x are y.

P2: Some Mathematicians are Scientists.

Some x are z.

C: Therefore, Some logicians are scientists.

 $\therefore$ Some y are z.

Argument 3

P1: All Philosophers are writers.

All x are y.

P2: Some Philosophers are poets.

Some x are z.

C: Therefore, Some writers are poets.

 $\therefore$ Some y are z.

We can observe clearly that the structure of these two arguments (argument 2 and 3) is identical. The difference consists in subject matter only and it is possible to construct numerous arguments having the same structure as argument 2 and argument 3. The essence of formal logic consists in saying that $P1 \ \& \ P2 \ \text{imply} \ C$. Only implication and entailment are relevant here. Strawson has made it clear that *implication or entailment is independent of subject matter*.

The logical principles or rules that are used to determine correctness (validity) and incorrectness (invalidity) of an argument are formulated on the basis of common logical features of the argument. Thus, the logical form of an argument is the most precious thing in logic. If the form of the argument gives a valid argument, then any argument which has the same form as that argument will be valid irrespective of the content of the argument or material truth of the statements used to form that argument. The formal logicians frame rules and formulae for testing the validity of arguments on the basis of logical form they possess. If there have been separate rules for each argument, then testing validity/ invalidity of argument would have become a cumbersome task. The representative formulae or the general rules of argument do not disagree with each other. They are connected and thus provide an ideal and organic system of logic.

Above description can be further clarified with the help of concepts of *constants* and *variables*. Let us represent terms used in the above two arguments by 'x', 'y' and 'z'. Represent the terms 'Mathematicians' and 'Philosophers' with 'x', 'Logicians' and 'Writers' with 'y' and 'Scientists' and 'Poets' with 'z'. Representative/symbolic form is shown on the right hand side of the respective arguments (argument 2 and argument 3). In this particular framework, without knowing the contents of 'x', 'y', and 'z' we can know that 'P1 and P2 together imply/ entail/leads to C'. The same explanation holds good for any invalid or inconsistent argument where premises do not imply conclusion.

Such forms are called logical forms. A logical form has two components: variables and constants x, y, z etc. in above examples are variables. Quantifiers like 'All', 'Some' and logical connectors/ operators like 'if then', 'either...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, and not by variables. Every class of argument has fixed constants. The structure of one class of

arguments is different from the structure of some other class of arguments. When the structure of an argument differs, the laws also differ.

Over centuries, logicians devised powerful techniques to discriminate valid arguments from invalid one. Though the traditional techniques and methods for determining validity differ from those used by modern logicians, the fundamental task is the same. To name few ‘six rules of valid categorical syllogism’, ‘Venn diagram method’, ‘nine rules of inference’, ‘ten rules of replacement’, ‘truth table method’, ‘shorter truth table (*reductio ad absurdum*)’ are some techniques discussed in deductive logic to check validity/invalidity of an argument or to construct formal proof of validity. Predicate calculus was introduced to make the internal structure of propositions more clear. It deals with forms of arguments which, on account of their complexity, are beyond the scope of propositional calculus.

The form or structures of argument and rules used to determine validity (invalidity) are mutually dependent. If it is possible to decide the structure of an argument and also different classes of arguments, then it is possible to achieve what is called formalization or systematization. So, *generality*, *form* and *system* are three features of formal logic.

Deductive logic provides a priori knowledge: We have observed in above discussions that like Mathematics, Logic is formal Science. It deals with relations which are applicable to actual as well as possible objects. It is deductive in character. Another similarity is that method of both is a priori i.e., independent of experience. Deductive arguments are like analytic statements. Knowledge obtained from an analytic statement is necessarily a priori, i.e. knowledge prior to sense experience. In analytic statements the predicate term is contained in the subject term. For example in the statement “All bachelors are unmarried” the term ‘unmarried’ is already contained in the subject ‘bachelor’. In deductive argument, conclusion is contained in the premises. Deductive logic provides knowledge a priori, though the premises and conclusion considered separately are not analytic. Let us explain it with the help of an example:

Argument 4: P1: All businessmen are wealthy people.
 P2: All wealthy people are philanthropists

 C: Therefore, all businessmen are philanthropists.

Evidently, there is no need to examine businessmen and wealthy people to know that the conclusion is true. Indeed, it is not even necessary that there should be businessmen who are wealthy as well as philanthropists. This being the case, argument takes the following form without leading to distortion of meaning.

“If all businessmen are wealthy people and all wealthy people are philanthropists, then all businessmen are philanthropists.”

The argument is transformed into a statement which involves relations. All hypothetical or implicative relations (the present relation is of one such kind) are such that without the help of sense experience, but only with the laws of formal logic, it is possible to derive a conclusion. Thus like an analytic statement, any valid deductive argument provides a priori knowledge and hence it is devoid of novelty. Here sense experience takes back seat and 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 of deductive reasoning: logical necessity, a priori and rational.

But sometimes the conclusion of an argument does not stand in such a necessary relation with premises. Quite often in our daily dealings we use non- deductive reasoning. Doctor’s diagnosis of the patient for finding the root cause of his/her illness is done in a non-deductive manner. Even legal experts/lawyers use inductive methods to decide what law governs in a particular case. Inductive arguments are tentative, probable, and provisional. No empirical science, natural or social, which aims to describe nature, world, or society, can do without induction. Let us now look at inductive reasoning in detail.

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. Analyze the relation between validity and formal character of deductive arguments.

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3.3 INDUCTIVE REASONING

In inductive reasoning, conclusion is drawn on the basis of some observed instances. This type of argument begins with sense experience. The premises of inductive argument are statements which directly result from sense-experience. However, the conclusion is not an observational statement i.e. its material truth is not known. In inductive reasoning, though the premises do not imply the conclusion with certainty, yet the premises give good reasons that suggest a particular conclusion. Contrast to the deductive reasoning, conclusion of an inductive argument doesn't get implied or entailed by the premises. Therefore, inductive reasoning does not provide a necessarily true and certain knowledge. The evidences (premises) only support the conclusion and do not entail it. Let us take an example of inductive argument:

Argument 5: P1: Professor x is a writer and he is wealthy.
P2: Professor y is a writer and he is wealthy.
P3:
P : multiple observations of the same kind
Pn:

Therefore, All professors who are writers are wealthy.

No matter how many observations we have, as stated in premises P1, P2...Pn, they cannot prove the conclusion 'All professors who are writers are wealthy.' The premises offer, at best, reasonable grounds to 'believe' in such a conclusion. However, 'belief' is not the same as proof. The statement 'All professors who are writers are wealthy' not only includes observed cases of Professors who are writers and wealthy, but also includes unobserved cases (of past and future). It is this component of unobserved cases and the leap taken in conclusion that is the root cause of endless debate on the nature of inductive inference. Uncertainty and sense experience characterize any inductive argument. Aristotle used the word 'epagoge' for 'induction' and C.S.

Peirce called them ‘ampliative’, as in this type of argument the conclusion always goes beyond the premises.

There is nothing contradictory in accepting all true premises and a false conclusion in inductive/non- deductive arguments. In the above example all the premises are true but the conclusion is only probable or may turn out to be false later on, and still it is not contradictory to accept it. If someday one comes across a professor who is a writer but not wealthy, this evidence will change the status of the above argument completely.

In deductive reasoning, it is impossible to deny the conclusion, when the premises are accepted as true, without contradicting itself. But inductive arguments escape from this contradiction. The reason is that the 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.

Let us take one more example here which has same form as argument 5 but is more appealing and strong:

Argument 6: P1: Crow X is black.
P2: Crow Y is black.
P3:
P : multiple observations of the same kind
Pn:

C: Therefore, All crows are black.

In this kind of argument one can never be sure that all crows are black in colour. It is possible that in future one may come across a crow which is not black in colour. Since one can not rule out this future possibility and the leap is taken in the conclusion on the basis of limited observations of the past and present, the conclusion is only probable not certain. Though argument 5 and argument 6 have same form with different content, argument 4 appears weaker and argument 6 to be stronger in drawing respective conclusions. In case of deductive reasoning arguments with the same form share the same truth value (both valid or both invalid) but in inductive reasoning depending on the content arguments with the same form have different strengths.

Logical form of two inductive arguments given above is as follows:

P1: The element x_1 of the set A has the property B.

P2: The element x_2 of the set A has the property B.

P3:

P : multiple observations of the same kind

P_n: The element x_n of the set A has the property B.

C: Therefore, all the elements of the set A have the property B.

The results of inductive reasoning are only probable. Inductive arguments are not evaluated as valid or invalid. The relation between evidences and conclusion is not of necessity but rather of suggestion. Probability is a matter of degree. Assume that 'truth' takes value '1' and 'falsity' takes value '0'. Then the numerical value of probability of conclusion varies from 0 to 1 without reaching either lower limit or upper limit. The favorable premises raise the probability value of conclusion, making the inductive argument strong. Addition of premises may change the status of argument from inductive to deductive, if on probability scale it becomes 0 (false) making argument invalid or 1 (true) making argument valid. Therefore, an inductive argument may consist of any number of premises, but what makes an argument more acceptable (strong) or less acceptable (weak) is the probability value that it takes. An inductive argument is evaluated by degrees such as weaker or stronger, appealing or non-appealing, convincing or non-convincing, etc. depending on the strength of evidences. A strong inductive argument with true premises is called a cogent inductive argument.

Here, it is necessary to remove a misconception regarding inductive arguments. It is held erroneously that inductive argument proceeds from particular premises to universal conclusion. Arguments 5, argument 6 and arguments with similar forms may also give this impression. Sometimes a distinction between inductive and deductive argument is also made on the same line. Deductive inferences are considered to go from general/ universal premises to the particular conclusion and inductive arguments from particular premises to general/ universal conclusion. But this is not always true. The conclusion of an inductive argument may or may not be in the form of universal statement but yes it is always based on some kind of generalization. In deductive arguments, the conclusion may or may not be a particular statement but it is true that premises always have one or more universal/ general statements. The error and misconception arise due to confusing universal statements with generalization. A universal

statement differs from generalization because a universal statement can be constructed within the limits of sense experience without involving generalization (which goes beyond sense experience). For example, when a teacher concludes after checking all the answer scripts of a class that every student of that class scored above 80 marks, the conclusion is a universal statement. But it is not an instance of generalization, because there is no leap from observed to unobserved or unobservable.

To make the above point more clear let us take one example of each; deductive and inductive reasoning where this dichotomy (that is, in deductive inferences particular conclusion is drawn from universal/ general premises and in induction universal/ general conclusion is drawn from particular premises) does not fit.

Argument 7: P1: All rectangles are quadrilaterals.

P2: All squares are rectangles.

C: Therefore, All squares are quadrilaterals.

Argument 7 is a valid deductive argument, where universal conclusion is inferred from universal premises.

Argument 8:

In a law court, a case of murder was presented in front of Judge. Mr. X was charged for murdering Mr. Y. The argument which was given against Mr. X was formed on the basis of following evidences:

Mr. X and Mr. Y were business partners for 23 years but things were not going well between them for the past 2 years. They had a dispute over a property which they purchased jointly. X was also not happy about a business deal which Y finalized without taking X's consent. Mr. X was seen in Mr. Y's office two days before Y's murder. On that day, Mr. Y's office staff heard Mr. X threatening and forcing Y to sign property papers. In police investigation Mr. X's fingerprints are also found on the weapon obtained from murder site.

These evidences strongly suggest that Mr. X murdered Mr. Y.

In the above inductive argument we moved from particular premises to particular conclusion.

What inductive reasoning provides in conclusion is merely a statement which depends upon experience, but in itself is not an experiential statement. No one has seen Mr. X murdering Mr. Y, but this conclusion is drawn with high probability based on the available evidences.

In some cases, experience can vouch for the conclusion, but in some other cases, it cannot. In inductive reasoning, conclusion is characterized by a sort of leap, leap from 'observed to unobserved/unobservable'. This is known as 'inductive leap' which always leads to generalization. Induction cannot even be conceived in the absence of generalization. In the above example also some generalizations are made. There is progress from particular observations to generalized statements (past experiences of similar situations where somebody murdered the other due to disputes, murderer fingerprint found on weapon lead to form generalization about all similar cases) and from them to particular conclusion. So generalization is used to reach this conclusion.

In Inductive inference both form and matter of an argument play a role in evaluation of its status. But more than structure of argument, the subject matter is relevant. The acceptability or relevance of the conclusion varies from one argument to another. Further, adding and subtracting some information from premises affect the conclusion of the inductive argument. It becomes strong or weak or changes its type from inductive to deductive on adding some more information. Addition of any future observation which contradicts previous observations will change the nature of inductive argument to deductive. Addition of this information that 'Mr. X was not in the city on the day Mr. Y was murdered' will change the status of the argument. Or availability of CCTV footage which shows presence of some other person on murder site will make argument weaker.

Consider one more example where inductive reasoning is used but is different in form from previous argument:

In the outbreak of Covid19 in 2019-2020 all over the world, people were made aware about the bodily symptoms of corona disease and advised to follow the prescribed guidelines to stop the

further spread of disease. On observation of multiple corona patients few symptoms were considered to be pointing out towards the presence of Corona disease. It had been observed that most people who were detected with Corona virus and hospitalized for its treatment had symptoms like high body temperature (fever), dry cough, loss of smell or taste or both, shortness of breath, mucus or phlegm, congestion or runny nose. So here on the basis of multiple observations a generalized conclusion is drawn about the presence of Corona virus in a person with above symptoms.

But later on different cases also came into picture where people who had no such symptoms were also found suffering with Corona and people who had some of the above symptoms were not detected with Corona. So, the presence of some symptoms or absence of them gave no certainty about drawing this conclusion that somebody is Corona positive or Corona negative. Unless and until that person's lab test is done, it is only a matter of speculation. This kind of reasoning is inductive in nature; we merely speculate something based on available evidences. Inductive arguments which appear to be strong at one point of time may lose their strength with addition of more observations which do not agree with previous observations.

This analysis makes two points clear. Content alters the acceptability of inductive argument and they are 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.

In inductive arguments the relation between premises and conclusion is like 'synthetic' statements where the meanings of subject and predicate are different, but otherwise related as in the case of the statement, 'The table in the dining area is round'. Synthetic sentences are descriptions of the world that cannot be taken for granted. It is possible to ascertain the truth or falsity of such proposition, but it is not possible to know it before sense experience.

Some cases of inferences are future-oriented and in principle '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*.

So inductive reasoning is synthetic, *a posteriori*, reason- based and has been used in natural and empirical sciences.

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. Explain briefly the characteristics of inductive reasoning.

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3.4 RELATION BETWEEN TWO TYPES OF REASONINGS

It is not correct to consider deduction and induction as opposed, antithetical or contradictory to each other. They are rather complementary and supplementary to one another. The relation between deductive and inductive reasoning is more like team mates in a race. One type of reasoning should not be considered to be more fundamental than the other. Deduction begins where induction ends. The conclusion of inductive reasoning may serve as a premise for deductive reasoning. They differ only in their ‘beginning points’.

Just as deductive logic has affinity with mathematics, inductive logic has affinity with the methods employed by the scientists. But to think that empirical sciences whether natural or social are purely inductive is not correct. The deductive reasoning also occurs in empirical sciences. If you look closely at argument 8 discussed above deductive reasoning followed up after inductive reasoning Arthur in his *An Introduction to Philosophy of Science* says “there is no other way of testing an empirical hypothesis- especially one of highly theoretical character, such as the hypothesis of universal gravitation, or the atomic hypothesis- than by deducing from it directly testable consequences.” (Arthur, P139)

3.5 ARGUMENTS AGAINST INDUCTIVE AND DEDUCTIVE REASONING

Hume says there are two possible types of arguments, “demonstrative” (equated with deductive) and “probable” (equated with inductive), but neither of them serve to draw some conclusion without fallacy. A demonstrative argument produces the wrong kind of conclusion, and a probable argument would be circular.

There are fewer criticisms raised against deductive arguments as compared to inductive arguments. One criticism that has been raised was by J. S. Mill against one type of deductive argument- syllogism (arguments with exactly two premises). In general, this is applicable to any deductive argument. Mill contends that syllogism just repeats the premises in the conclusion without going any further i.e. syllogisms are circular or non-ampliative and thus trivial. Mill claims that all attributes (terms, premises, and conclusion) are logically independent. Here, if we refer to argument -1 discussed above (All men are mortal, Mahatma Gandhi is a man. Therefore, Mahatma Gandhi is mortal.), Mill’s claim says that the truth of the major premise adds nothing to the truth of the particular propositions, ‘this man is mortal,’ ‘that man is mortal’, etc., whose conjunction it records. Accepting the major premise as true is simply a way, on the one hand, of accepting that particulars, one already knows, share the attributes in question (mortality), and, on the other hand, a determination that one will continue to affirm this connection of hitherto unexamined particulars. Deductive logic or syllogism adds nothing to our knowledge. The rules of formal logic, of syllogistic logic, are the rules of logic of consistency. We referred to this problem of novelty in 3.2, and also saw a powerful response to this objection.

But the objections raised against induction are more severe. The challenge for the empiricist is how to get universality and generality, necessity, and normativity out of particular, contingent experiences.

At first, inductive reasoning is not regarded as logical at all since in inductive arguments the truth of the conclusion does not necessarily follow from the truth of premises. This objection can be met by arguing that deductive standards need not to be applied to inductive logic, lest the distinction itself becomes superfluous.

Hume demonstrated that deduction cannot be used to explicitly prove the truth value of an inductive inference. The inductive inference to be proved must be taken as an axiom, thereby leading to circular logic between the premise and conclusion. Thus, inductive inferences are open-ended, and acting upon them requires faith that no contradictory case will eventually appear. Hume showed that we are not epistemically justified in using induction (though there is a psychological story that explains our confidence). 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 law in science, then this principle stands in need of justification, and so on.

Salmon, Max Black and Urmson defend induction whereas Russell and Popper reject induction. Popper's theory is known as anti-inductivism or non-inductivism. Popper replaces verifiability by falsifiability.

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. Explain the concepts 'analytic and synthetic' and 'a priori and a posteriori'.

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2. Comment upon the criticisms made against deductive and inductive inferences.

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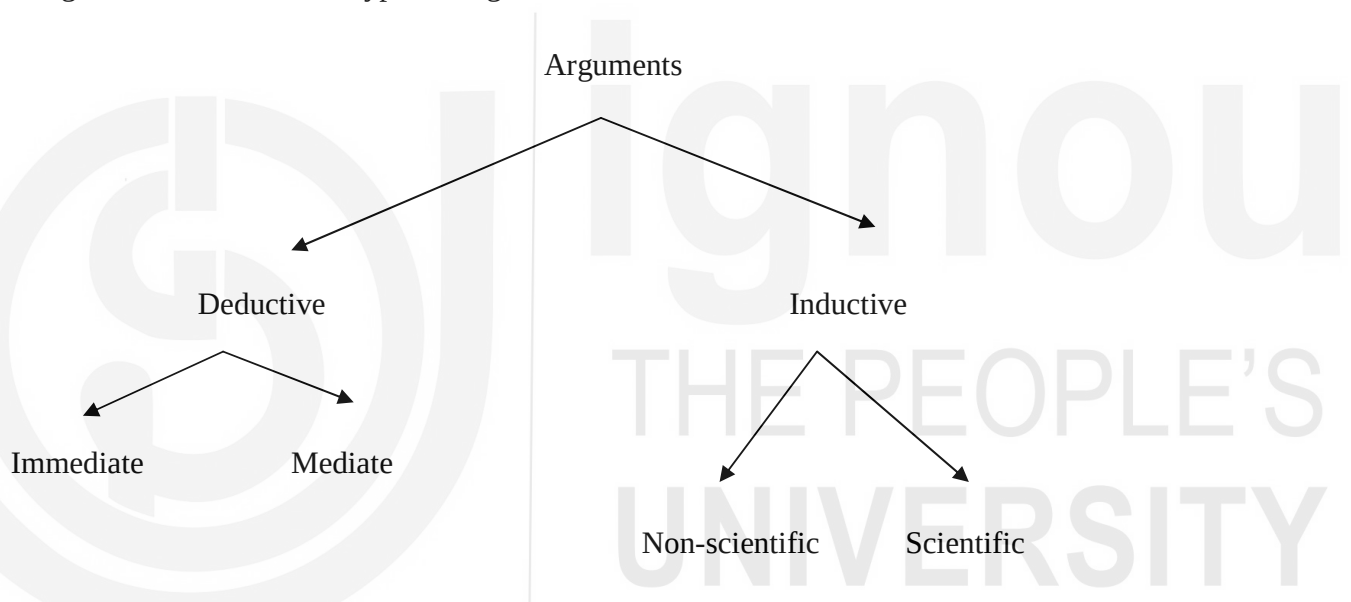
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3.6 TYPES OF INDUCTIVE ARGUMENTS

In deductive logic different types of deductive arguments are discussed based on the form of the argument. The form differs based on the number of premises and how terms, premises-

conclusion is arranged in relation to each other. In the deductive reasoning conclusion is certain and there is no difference in type of deductive arguments based on conclusion. On the other hand in inductive reasoning the conclusion differs in degree. Inductive reasoning takes specific information and makes a broader generalization, but there are other forms also different from generalization. There are other forms of inductive arguments in which conclusions are drawn by appeal to evidence, or authority, or causal relationships. Different methods used in deductive logic to find validity of arguments are the subject matter of your present logic course. It's been discussed at length in the next two blocks. Here in this section we will take a brief look at type of inductive arguments specifically type of inductive generalizations. Broader sub-categorization of these two types of arguments can be done as follows:

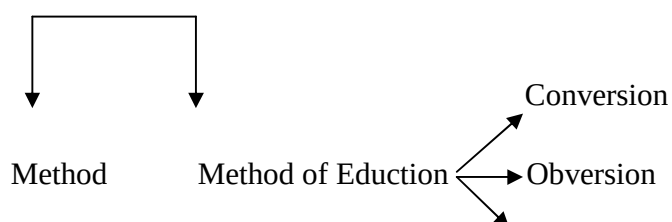


Graph 1: Arguments: deductive and Inductive

Immediate

(Arguments

having one Premise)



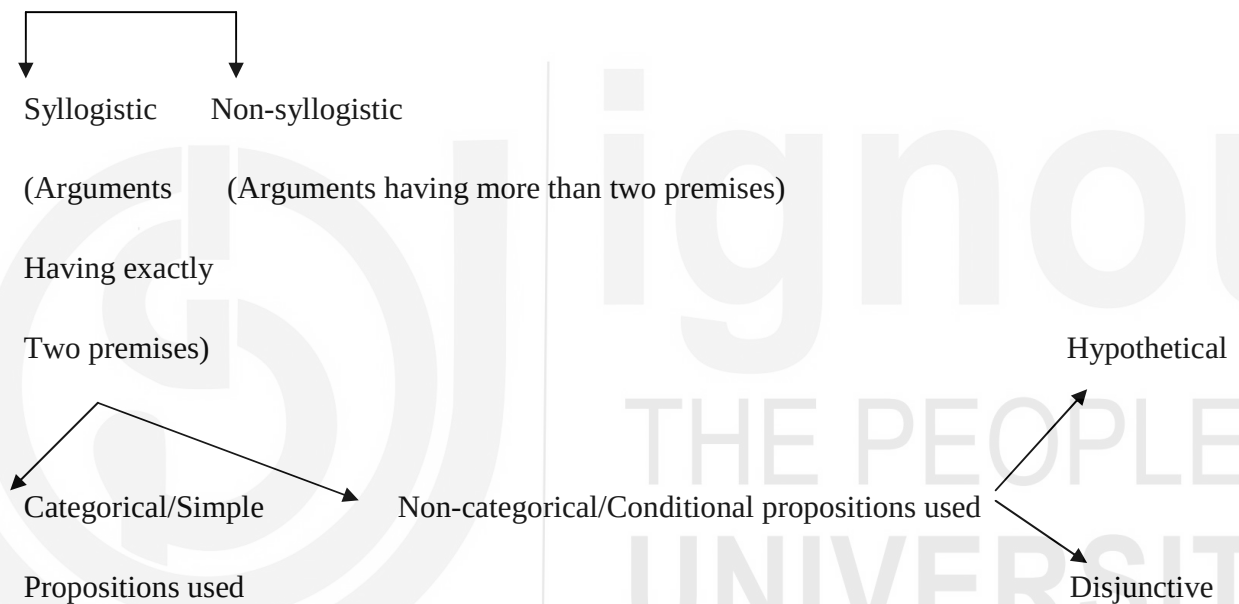
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Contraposition

Opposition of Proposition

Graph 2: Immediate Argument

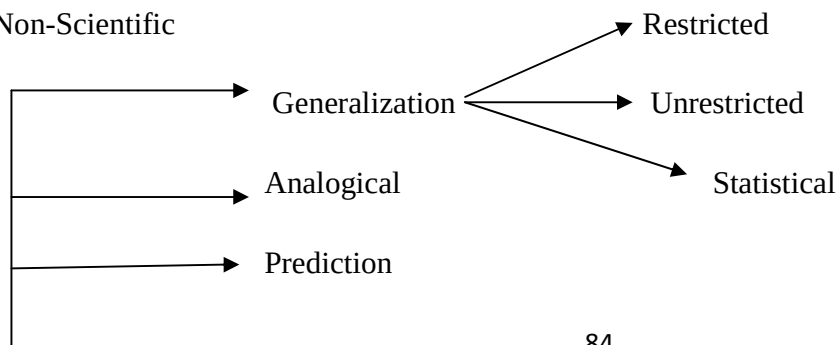
Mediate



Graph 3: Mediate Argument

(Inductive)

Non-Scientific



—————→ Based on Authority

Graph 4: Non-Scientific

Scientific



Causal (Methods of Finding Causal Relationships: Method of agreement, Method of disagreement, Joint method, Method of residues, Method of concomitant variation)

Graph 5: Scientific

Let us now have a look at types of inductive reasoning:

Generalization: Inductive generalization proceeds from specific sample observations to general ideas about the whole population. In generalization one draws conclusions based on recurring patterns or repeated observations. To generalize, one observes multiple instances and finds common qualities or behaviors and then makes a broad or universal statement about them. There are some fallacies related to this type of generalization known as hasty generalization and biased sample usage. When generalization is done after observation of all the cases then it is known as induction by complete enumeration.

There are three types of generalizations: unrestricted, restricted and statistical.

Generalization is said to be unrestricted when it does not include exceptions in any form. It is restricted when some restrictions are imposed individual, spatial or temporal. Development in certain fields like statistics has given rise to a different type of generalization which may be called statistical generalization. Statistical generalization requires a fair sample within which a study is undertaken yielding a certain ratio. This is, surely, an example of 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 a 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.

Analogical: Inductive analogy proceeds from known similarities between two things to a conclusion about an additional attribute common to both things. If some attribute A is true for X, Y and Z and later on we find that X and Y have attribute B, we based on analogy infer inductively that it is most likely that Z also possesses attribute B. The fallacy of false analogy is related to this process. Analogy excludes generalization of all types. Still, it is inductive, because with its help we pass from ‘observed’ to ‘unobserved’. This particular inference is, evidently, intuitive and 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.

Prediction: a conclusion about a future individual from a past sample.

Induction based on authority: An argument from authority draws a conclusion about the truth of a statement based on the proportion of true propositions provided by an authoritative source. It has the same form as a prediction.

Causal: A causal inference draws a conclusion about a causal connection based on the conditions of the occurrence of an effect. Premises about the correlation of two things can indicate a causal relationship between them, but additional factors must be confirmed to establish the exact form of the causal relationship.

3.8 LET US SUM UP

Reasoning is of two types: inductive and deductive.

Deductive Reasoning:	Inductive Reasoning:
• The relation between premises and conclusion is that of necessity. Premises are sufficient to draw a conclusion beyond any doubt. • Addition of more statements to premises does not change the	• The relation between premises and conclusion is probable. Premises merely suggest a conclusion but do not entail or imply it. • Addition or subtraction of information changes the status of conclusion in an

conclusion of a valid deductive argument. • Deductive reasoning is formal in character. Form decides the status of the argument. • Deductive argument is evaluated either as valid or invalid. • Valid arguments may consist of either true statements or false statements. But a significant aspect of valid deductive argument is that a false conclusion cannot be drawn from all true premises. • Sense experience is irrelevant in deductive logic. Intellect is the key to deductive inference. • Logical certainty, a priori nature and rationality are the qualities of deduction.	inductive argument. • In induction content/ matter determines acceptability of inference. • Inductive arguments are evaluated as strong or weak, acceptable or not acceptable, sound or unsound, appealing or non-appealing. • There is nothing contradictory in accepting all true premises and a false conclusion in an inductive argument. • Premises are observational statements based on sense experience. Generality (in conclusion) is the characteristic of induction. • Inductive inference is probable, uncertain, <i>a posteriori</i> and empirical.
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3.9 KEY WORDS

Probability: Probability is a technical term used extensively in all sciences which use quantitative analysis. It is, generally, issued to deal with projection which is future-oriented or past-oriented. It is always expressed in proper fraction where the denominator points to the total number of possibilities and the numerator points to the issue at stake.

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.

Hypothesis: A hypothesis consists either of a suggested explanation for an observable phenomenon or of a reasoned proposal predicting a possible causal correlation among multiple phenomena.

3.10 FURTHER READINGS AND REFERENCES

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3.11 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. Only statements are true (or false) whereas only arguments are valid (or invalid). We generally think that combination of true statements will lead to valid arguments and false to invalid, but this is not the case. All true statements may give an invalid argument or all false statements can give valid arguments. Validity or invalidity of the argument depends on the form of the argument. It means that truth and validity may or may not coincide with each other. But, in any valid deductive argument false conclusions cannot be drawn from all true premises. In this case, necessity is of a particular kind, i.e. logical necessity.

Check Your Progress II

1. In inductive reasoning the relation between premises and conclusion is probable. Premises merely suggest a conclusion but do not entail or imply it. Premises of the inductive reasoning are observational statements based on sense experience. Generality (in conclusion) is the characteristic of induction. Probability of inference is a matter of degree which is always in a variable fraction. Inductive arguments are evaluated as strong or weak,

acceptable or not acceptable, sound or unsound, appealing or non-appealing. In induction content/ matter determines acceptability of inference. Addition or subtraction of information changes the status of conclusion. This may make inference more strong or weaken it. There is nothing contradictory in accepting all true premises and a false conclusion in inductive argument. Inductive arguments are uncertain, *a posteriori* and empirical.

Check Your Progress III

1. Analytic sentences are true by definition, and are self-explanatory. Let us take an example: 'All bachelors are unmarried men'. This statement is true in virtue of the meaning/ definition of the word 'bachelors'. In analytic statements the predicate term is contained in its subject term. 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. In synthetic statements the predicate term is not contained in its subject term but related to it. Consider the example 'All creatures with hearts have kidneys.' Here the subject 'creature with heart' does not contain this information that they 'have kidney'. Inductive arguments are considered to be of the nature of synthetic judgments.

2. Induction has attracted more criticism than deduction. The criticism against deduction was made by J.S. Mill with reference to one type of deductive argument known as syllogism. Mill contends that syllogism is guilty of repeating the premises in conclusion. 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. Hume raises objections to one form of induction known as ampliative induction. Generalization is considered a hallmark of inductive reasoning. The objections to generalization are formulated on one ground; no proof in strict mathematical or deductive sense is possible when we deal with induction. Inductive inference can only be vindicated because any attempt to justify the

same runs into infinite regress or becomes circular. Generalization can only be disproved or falsified though it cannot be proved.

UNIT 4 TRUTH AND VALIDITY*

Structure

4.0 Objectives

4.1 Introduction

4.2 Truth and Logic

4.3 Validity and Logic

4.4 Assessment of Deductive Logic

4.5 Sound and Unsound Deductive Arguments

4.6 Significance of Validity in Deductive Logic

4.7 Assessment of Inductive Logic

4.8 Comparison of Deductive and Inductive Arguments

4.9A Brief Note on Indian Logic

4.10 Let us Sum Up

4.11 Key Words

4.12 Further Readings and References

4.13 Answers to Check Your Progress

4.0. OBJECTIVES

The objective of this unit is to introduce you to the concepts of Truth and Validity in Logic. Understanding the concepts like Truth and Validity and their relationship plays a crucial role in evaluating arguments, i.e., in distinguishing good from bad arguments. Through the analysis of different aspects of Truth and Validity in Logic we can learn:

- the meaning and importance of truth in Logic

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- the meaning and importance validity in Logic
- the relationship between truth and validity in Deductive Logic
- the application of similar concepts in Inductive Logic
- the application of similar concepts in Indian Logic

4.1 INTRODUCTION

The fundamental aim of Logic is to provide an apparatus for distinguishing between good and bad argument. In the preceding units we have learnt about the nature of Logic and the nature of Deductive and Inductive Logic. In this unit you shall learn the terminologies and concepts that are used in formal logic to evaluate arguments and to distinguish between good and bad arguments. Two such concepts are “Truth” and “Validity” and their inter-relationship. The evaluation of an argument can be carried out through an exploration of following questions: (a) Are all the premises of an argument true? (b) Do the premise/premises support the conclusion? This second question is specifically more pertinent because an answer to this can help us determine the value of an argument. Additionally, we also need to determine the manner and the extent to which the truth or falsity of the premises effects the evaluation and the value of argument. In the course of the present unit, we shall learn the concepts and terminology used in this respect and explore these issues as they appear across deductive and inductive arguments.

4.2 TRUTH AND LOGIC

Let us first understand the concept of truth and its relevance in Logic. Truth is an attribute of a proposition and it refers to what is really the case. A proposition is an assertive sentence that can be either true or false. So “truth” and “falsity” are truth values of a proposition. A proposition can be a premise of an argument and it could be true. Also a proposition could be a conclusion of an argument and it could be false. Take the following argument:

All men are immortal. (Premise 1)

Hari is a man. (Premise 2)

Therefore, Hari is immortal. (Conclusion)

Here premise 1 is false, premise 2 is true, and the conclusion is false. The truth value of the above propositions is known to us. But logic is not concerned about whether these propositions are actually true or not. Logic tries to determine, in a case where the given premises are true, if we can necessarily draw the conclusion from the premises. This leads to the issue of validity.

4.3 VALIDITY AND LOGIC

Validity is a fundamental concept of Logic. According to logician I. M. Copi, “Validity is a formal characteristic; it applies only to arguments, as distinguished from truth, which applies to [individual] proposition[s]”. Validity is an attribute of an argument. An argument is valid if the relationship between its components are so that the premises conclusively prove the conclusion. That means, validity is about the logical connection between the propositions. Take the following example:

All men are saints.

Einstein is a man.

Therefore, Einstein is a saint.

The conclusion of this argument necessarily follows from the premises. In the above argument, if the premises were true, then there is no possible scenario where the conclusion would be false. Therefore, this argument is a valid one. Conversely, if the conclusion is not a logical necessity, then the argument is not valid, and it will be called an invalid argument. Now one can raise a question here concerning whether the validity of the argument is decided by the truth value of the proposition; more precisely one may ask- what is the exact connection between truth and validity in the context of an argument? We shall discuss that in a while. Before that we need to understand two things clearly.

First, in ordinary language ‘validity’ can be used interchangeably with ‘truth’ and vice versa, but in Logic, the concept of validity applies only to arguments, and the concept of truth applies exclusively to propositions.

Second, the definition of validity as a “logical necessity” confines the concepts of validity and invalidity to Deductive Logic only. Because, according to I. M. Copi, deductive arguments make

the claim that its premises conclusively support the conclusion, while in case of Induction, the premises do not conclusively support the conclusion.

Keeping in view this clarification, in the next section we shall explore in greater detail the concept of validity and its relationship with truth in Deductive Argument.

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. In general what makes an argument valid?

2. Is validity dependent on the actual truth of propositions?

4.4 ASSESMENT OF DEDUCTIVE LOGIC

It is clear that validity as a logical concept is exclusively applied on deductive arguments only and therefore it is an important part of any discussion on Deductive Logic. Validity can be properly defined in the context of deductive arguments. The objective of deductive arguments is to establish that the conclusion undeniably follows from the premises. When it achieves this objective, the argument is said to be valid, and when it fails to achieve this objective then the argument is not valid and therefore it can be termed as being an “invalid” argument.

But how do we know that a deductive argument has achieved its objective? How do we ascertain whether the argument is valid? In reply to this query, it may be noted that if the premises are true

in a deductive argument, and there is no logical possibility of the conclusion being false, then it is a valid. Let us consider an example:

All Fast foods are unhealthy.

French Fry is a Fast Food.

Therefore, French Fry is Unhealthy.

We know that if the premises in this argument are true then the conclusion can never be false. Therefore, this is a valid argument. The validity is determined by the relationship between the premises and the conclusion. If the object “French Fry” is included in the group of “Fast Food” (second premise) and if “Fast food” is included in the group of “unhealthy” things (first premise), then the object “French Fry” is necessarily included in the group of “unhealthy” things (conclusion). You can see that the above relationship gives a particular form of the argument and this form is a valid one. Because, in this form, if we assume that the premises are true, then the conclusion will be necessarily true, and to claim it as false will be contradictory. Interestingly if we use an argument with utterly false propositions, yet fulfilling the same argument “form” like the one given above, it will still be valid.

All mammals have wings.

All plants are mammals.

Therefore, all plants have wings.

All the propositions in the above argument are false, but the argument is still valid, because the logical relationship of the propositions is such that if the premises were actually true, the conclusion would be certainly true.

The two sets of examples discussed above, however raise a serious question with regard to the nature of the relationship between truth and validity in deductive arguments. It may be asked whether there is any connection between the truth value of the proposition and validity/ invalidity of the argument? Deductively Logic largely engages in answering these questions and formulating rules and principles for determining validity. In this Unit, however, we shall develop an outline of the critical and complicated relationship of truth and validity.

As we have seen earlier, the relationship between argument and propositions is a structural one. The validity and invalidity of an argument depends on the logical relationship between its propositions. Propositions are constituent parts of an argument. Every argument can have one proposition as conclusion and at least two or more propositions as premises. Each proposition can be true or false, and every argument must be either valid or invalid. Logicians have noted that there are several arrangements of truth/falsity and validity/invalidity. These arrangements will provide crucial clues to understand the relationship between truth and validity in Deductive Logic. Let us explore those arrangements with examples.

Arrangement 1: *True Premises, True Conclusion, Valid Argument*

Example: All mammals are animals.

All cats are mammals.

Therefore, all cats are animals.

In this argument, all the propositions are known to be true. The premises conclusively establish the conclusion; therefore, making the argument “valid”.

Arrangement 2: *False Premises, False Conclusion, Valid Argument*

Example: All mammals are six legged animals.

All Ostriches are mammals.

Therefore, all Ostriches are six legged animals.

In this argument, all the propositions are known to be false. But here the premises conclusively establish the conclusion, because if the premises were actually true, the conclusion would have been certainly true. Therefore, this argument is also valid.

Arrangement 3: *True Premises, True Conclusion, Invalid Argument*

Example: If I won the KBC Show, I would be a millionaire.

I did not win the KBC show.

Therefore, I am not a millionaire.

The premises and conclusion here are true, the argument is invalid because the conclusion does not necessarily follow from the premises. This will be further clear from the next example.

Arrangement 4: *True Premises, False Conclusion, Invalid Argument*

Example: If Ratan Tata won the KBC Show, he would be a millionaire.

Ratan Tata doesn't win the KBC show.

Therefore, Ratan Tata is not a millionaire.

In this argument the premises are true, but the conclusion is false in reality. Mr. Tata till now didn't participate in KBC show, but he is one of the richest persons in India. The argument is invalid because the premises don't conclusively establish the conclusion.

Arrangement 5: *False Premises, True Conclusion, Valid Argument*

Example: All Fishes are mammals.

All dolphins are fishes.

Therefore, all dolphins are mammals.

The conclusion here is true in reality, but the premises are unquestionably false. However, since there is a logically necessary connection between the premises and the conclusion, because of which the premises conclusively support the conclusion, the argument is valid.

Arrangement 6: *False Premises, True Conclusion, Invalid Argument*

Example: All mammals have wings.

All dolphins have wings.

Therefore, all dolphins are mammals.

This argument has two false premises and still the conclusion is true. However, the argument is invalid, because the conclusion is not conclusively supported by the premises. We know that by examining the form of the argument. Here, in the second premise the group "all dolphins" belongs to the group "wings", and in first premise, the group "all mammals" belong to the group "wings", and these don't prove whether the group "all dolphins" belong to the group "mammals"

Arrangement 7: *False Premises, False Conclusion, Invalid Argument*

Example: All mammals have wings.

All dolphins have wings.

Therefore, all mammals are dolphins.

In this argument both premises and conclusion are false. And the argument is invalid. Because the conclusion is not supported by the premises. Like Arrangement 6 above, here also in the second premise the group “all dolphins” belongs to the group “wings”, and in first premise, the group “all mammals” belong to the group “wings”, and these don’t prove whether the group “all mammals” belong to the group dolphins” (in most of the above examples we have used particular form of Deductive Argument known as Categorical Syllogism. We shall learn more about this type and the methods of checking the validity of such arguments in Block: 3 Categorical Syllogism)

Arrangement 8: True Premises, False Conclusion, Valid Argument

Example: Nil

By definition, in a deductively valid argument if the premises are true, it is impossible for the conclusion to be false. If the conclusion is false, when premises are true, that means the conclusion is not conclusively supported by the premises. Therefore, the argument will be always invalid. That is why there is no example of **Arrangement 8**.

The above discussion on the eight possible arrangements (of which the 8th arrangement is, in fact, impossible) of true and false propositions and valid and invalid arguments reveals that firstly, truth or falsity of the conclusion of an argument cannot determine on its own the validity or invalidity of an argument, and, secondly, validity of an argument does not guarantee the truth of its conclusion. Valid argument can have all false propositions and invalid argument can have all true propositions. Sometimes, false premises can lead to true conclusion in valid as well as invalid arguments.

This complex and critical relationship can further be exposed in the following table.

Premise	Conclusion	Validity
True	True	Valid/Invalid
True	False	Invalid
False	True	Valid/Invalid

False	False	Valid/Invalid
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This table shows that the validity or invalidity of an argument cannot be determined merely from the truth and falsity of the propositions. Both valid and invalid arguments can have all true propositions or all false propositions, or they can have false premises and a true conclusion. As we have seen there are seven possible combinations of truth/falsity and validity/invalidity. The combination that is impossible is a combination of valid argument with all true premises and a false conclusion. To put it differently, we can say that if there is a false conclusion in a valid argument, then at least one of its premises must be always false. Thus there is one instance where truth and falsity is a determining factor for validity/invalidity. Any deductive argument having actual true premises and actual false conclusion is always invalid. Because, if the premises are actually true, and the conclusion actually false, then it is *possible* that the premises can be true and conclusion can be false. But we already know that in a valid deductive argument if the premises are true, then it is *impossible* for the conclusion to be false.

4.5 SOUND AND UNSOUND DEDUCTIVE ARGUMENTS

The evaluation of deductive argument is not limited to identifying valid and invalid arguments. Depending on its relationship with truth, arguments can be further classified as “sound” and “unsound”. A sound argument is a deductive argument that is valid and it has true premise. It must satisfy two conditions: the argument must be valid, and the premises must be true. If any of this condition is not met, then no valid argument can be termed as sound. Consider the following argument:

All planets of the solar system revolve around the Sun.

The Earth is a planet of the Solar System.

Therefore, the Earth revolves around the Sun.

This argument is valid because the logical relation between the propositions are so that if the premises were true, then the conclusion would be certainly true. This argument is valid and in addition, the premises here are actually true. So this is a Sound deductive arguments. Now one can ask whether the conclusion in such a case will also be true? The answer is always yes.

Because, by definition of validity, if the argument is valid and if its premises are true, then it is impossible for the conclusion to be false. We already know that in a sound argument the argument is valid and the premises are actually true, therefore, now we can say that the conclusion will be actually true.

In contrast to Sound argument, unsound arguments are those which do not satisfy the conditions of a sound argument. To put it clearly:

1. An argument which is invalid is unsound.
2. An argument which is valid but has false premises is unsound.

Following these conditions, if we consider the eight arrangements of truth and validity described in section 4.4 we shall find that only **Arrangement No.1** is sound. All other possible combinations of truth/falsity and validity/invalidity are always unsound. Thus **Arrangement no.1** is an instance of a sound deductive argument which is valid and has actual true premises, and therefore, by definition, always gives an actually true conclusion. A sound argument can also be termed as a good deductive argument in the fullest sense of the term. All deductive arguments are either sound or unsound.

4.6 SIGNIFICANCE OF VALIDITY IN DEDUCTIVE LOGIC

It is obvious from our discussions so far that logicians are interested in the evaluations of arguments, rather than in the evaluation of propositions. The evaluation of deductive arguments is measured in terms of validity and invalidity. Valid and invalid arguments are further evaluated as sound and unsound arguments. Sound arguments are what can be termed as good arguments, that can lead us to actually true conclusions with utmost certainty. In such a situation, one can ask, why logicians do not confine themselves to the study of arguments with true premises only as that may lead us to sound arguments? What is the importance of the non-sound valid arguments? Specially, what is the importance of exploring valid arguments whose premises are not true?

Actually the validity of arguments with premises not known to be true are more important than they seem to be. In our day-to-day life, we often need to choose between alternative courses of action where we do not know which alternative is in fact true. What we do is consider

consequences of these alternative courses. On considering the consequences, we decide which course of action should be followed. We need to be serious in deciding the consequences of the alternative courses. That is where our training in valid argument with false premises can help us. Because, in case of valid argument with false premise, the logical relation between premises and conclusion is such that if the premises were true, the conclusion would be also true. If we follow a similar valid logical process in deciding the consequences, then we can correctly choose the alternative course of action. Thus here we “make” (as I. M. Copi puts it) the premises true out of the available alternative courses. But if we deal with only already known true premises, then there will be no point in considering alternative courses, we can accept the one which is true. The purpose of applying logic here will be self-defeating. But the reality is that there will be always alternative courses in life where truth of the alternatives may not be known to us.

Another important aspect is the use of deductive logic in the Sciences. Scientists often verify scientific theories using deductive method. Many theoretical premises cannot be verified as true. But scientist can deduce particular testable instances from such theories. Such particular instances can be tested for truth, which further confirms the theory in question. But this will only work, if the process of such a deduction follows a valid path.

Check Your Progress II

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

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

1. Give an example of a valid argument with all false propositions

2. Give an example of an invalid argument with all true propositions

3. What is the difference between valid and sound argument?

4.7 ASSESMENT OF INDUCTIVE LOGIC

Our understanding of Truth and Validity in Deductive Logic can be further enhanced by considering the case of Inductive Logic. Every deductive argument claims that its conclusion necessarily follows from the premises, that means that if the premises are true then it is *impossible* for the conclusion to be false. The task of a logician is to verify these claims. If the claim is correct the argument is valid, if the claim is incorrect, the argument is invalid. There is no middle ground between valid and invalid. In contrast, an inductive argument claims that the conclusion *probably* follows from the premises, i.e., to say if the premises are true, then it is improbable for the conclusion to be false. Logicians examine these claims of probability. But probability is a matter of degree. There is no certainty of the conclusion being true, even if the premises are true, even if the procedure of induction is correctly followed. Therefore, the terms “validity” and “invalidity” are not applicable here. In fact, there is no term fixed by logicians to identify good and bad inductive arguments. However, the terms “Strong” and “Weak” are used by some logicians for the evaluation of inductive arguments.

An inductive argument is strong when it achieves its objectives. The objective of an inductive argument is to establish that it is improbable for the conclusion to be false when the premises are true. The conclusion here has a probability of being supported by the premises. On the other hand, a weak inductive argument is the one which fails its objective. So in a weak inductive argument, the conclusion does not probably follow from the premises, even though it is claimed so.

Now let us focus on the evaluation of inductive arguments through an examination of the relationship between truth/falsity and strength/weakness of inductive arguments. The testing of the strength of inductive arguments is comparable to testing of the validity of deductive arguments. In inductive arguments also, we assume that the given premises are true, and on the basis of this assumption we try to determine whether the conclusion is probable. Like deductive arguments, here also we need to establish the connection between premises and conclusion. But unlike deductive arguments, in inductive arguments we cannot just focus on the form of the argument. The conclusion of an inductive argument could be a generalization, an analogy, a prediction, etc. There is always a “leap” from certain to uncertain, from particular to general, because the conclusion tends to contain more information than the premises. This “inductive leap” is possible because of two principles, that are also known as the formal grounds of induction. The first principle is the Law of Uniformity of Nature and the second principle is the Law of Causation. According to the law of uniformity of nature there is uniformity in nature, i.e., under similar conditions nature behaves in a similar manner, that is to say that the future repeats the past. The Law of Causality states that every event has a cause, so if X is the cause of Y, whenever there is X, it will always be followed by Y. On the basis of these principles, if we proceed from particular premises to a general conclusion in Induction, the argument will be strong and the probability of the conclusion being true would be very high.

Now instead of considering the varieties of inductive arguments and the different methods of justification of induction, let us consider how the truth and falsity of propositions of inductive arguments are related to their strength and weakness. Here also we can find several arrangements parallel to arrangement that we examined in case of deductive argument.

Arrangement 1: True Premises, Probably True Conclusion, Strong Argument

Example: Every year in last decade there were always heavy rainfall during monsoon in Assam.

Therefore, probably there will be heavy rainfall in the monsoon of this year in Assam.

In this argument the premise is actually true, as there was heavy rainfall every year in last decade during monsoon in Assam. The uniformity of nature dictates that in the next monsoon also there will be heavy rainfall in Assam. This is also what we naturally expect to happen. Thus the conclusion is probably true, and the argument is strong.

Arrangement 2: True Premises, Probably True Conclusion, Weak Argument

Example: In 1917, 1996 and 2019, there were heavy rain fall during monsoon in Rajasthan.

Therefore, probably there will be heavy rainfall during next monsoon in Rajasthan.

In this argument, the premise is actually true, the conclusion is probably true. Here we can't apply the law of uniformity of nature as we have supporting information about only three years in a range of more than 100 years. The argument, thus, is a weak one.

Arrangement 3: *False Premises, Probably True Conclusion, Strong Argument*

Example: Every Indian Prime Ministers was a poet.

Therefore, it is probable that the next Indian prime minister will also be a poet.

Here the premise is actually false (some of our prime ministers were good poets, but not everyone was a poet). But if we assume that the premise is true, then we would naturally expect that the prime minister will be a poet. So, the argument is strong.

Arrangement 4: *False Premises, Probably True Conclusion, Weak Argument*

Example: Some Indian Prime Ministers were logicians.

Therefore, it is probable that the next Indian prime minister will be a poet.

Here the conclusion is probably true, but the premise is clearly false and even if we assume the premise as true, we cannot find any link between it and the conclusion. Therefore, the argument is weak.

Arrangement 5: *False Premises, Probably False Conclusion, Strong Argument*

Example: Every Rhino discovered in Assam are two-horned.

Therefore, probably the next Rhino discovered in Assam will be two-horned.

In this argument the premise is clearly false, the conclusion has a high probability of being false. But if we assume the premise as true, then we naturally expect that the conclusion would have been also true. Therefore, the argument is strong.

Arrangement 6: *False Premises, Probably False Conclusion, Weak Argument*

Example: Few Rhinos discovered in Assam are two-horned.

Therefore, probably the next Rhino discovered in Assam will be two-horned.

In this argument, like the previous one, the premise is clearly false, the conclusion has a high probability of being false. But even if we assume the premise as true, the premise does not strongly support the conclusion as the considered instances are very few, so there is very low probability of the conclusion being true, in other words, it has a probability of being false. Therefore, the argument is weak.

Arrangement 7: *True Premises, Probably False Conclusion, Weak Argument*

Example: A few Indian Space Missions have failed.

Therefore, probably the next Indian Space Mission will fail.

Here the premise is actually true. But the conclusion has a high degree of being false because relevant instances are very low leading to very low degree of probability. Therefore, the argument is weak.

Arrangement 8: *True Premises, Probably False Conclusion, Strong Argument*

Example: Nil

If an inductive argument is strong, and if its premises are true, then the probability of the conclusion being true will be high. Therefore, Arrangement 8 is not possible.

The discussions on these possible arrangements make it clear that the relationship between truth/falsity and strong/weak inductive argument is a complex one. In most of the cases, truth of the premise or strength of the argument do not correlate. That is because the strength of argument is not dependent on the actual truth of the premises, but on the probabilistic support given by the premises to the conclusion. All that the arrangement of truth and falsity establishes is that if the premises are true and conclusion is probably false, then the inductive argument is weak. In other words, if the argument is strong and the premises true, the conclusion is probably true.

As logician Patrick J. Hurley emphasizes, we need to note two important points here. First, in case of true premise in inductive argument, the term “true” shall be taken in its fullest sense. The true premise, thus, should not miss or undermine any crucial information, so that no scope is left for a different conclusion than the intended one. Secondly, in induction when we claim a

conclusion as probably false, it means probably false in the actual world in the context of actually known evidence.

Now let us summarize the relationship between strength of Inductive argument and truth and falsity of premises and conclusion.

Premise	Conclusion	Strength
True	Probably True	Strong/Weak
True	Probably False	Weak
False	Probably True	Strong/Weak
False	Probably False	Strong/Weak

This table makes it clear that merely from the truth and falsity of propositions the strength of argument cannot be ascertained. But when the premises are true and the conclusion probably false, then the argument is weak. Because if the premise is true in the sense explained above, and the argument is strong, then conclusion would be probably true instead of being probably false.

The above table can be drawn parallel to the table drawn for deductive argument. However, there is one major difference. In case of deductive argument, the truth of conclusion is absolute, i.e., it can be either true or false. But in case of induction the truth of conclusion is a matter of degree. In a strong argument it has a probability of being true, in weak argument, it has higher probability of being false. The degree of probability depends on how the premises are supporting the conclusion.

Thus if we consider Enumerative Induction which relies on simple enumeration of available instances we can see how the degree of probability shifts depending on considered instances.

Example 1. The 5 mangos checked randomly from the bag of 100 mangos are ripe.

Therefore, probably all 100 mangos in the bag are ripe.

Example 2. The 80 mangos checked randomly from the bag of 100 mangos are ripe.

Therefore, probably all 100 mangos in the bag are ripe.

The first example is a weak argument and the second is a strong argument. But they are not absolutely strong or weak. Adding additional instances in first case may increase its probability, removing instances from the second will decrease its probability. Also, addition of new information can also affect the strength of inductive argument. For example, if we add the premises “3 mangos were checked and found to be unripe and removed from the bag” will make both the arguments weaker. Thus, for inductive argument to be strong, the premises must provide probabilistic support to the conclusion.

The categorization of strong and weak inductive argument helps a logician’s endeavor to distinguish between good and bad arguments. But the process is not limited to this division only. Some logicians further divide inductive arguments into Cogent and Uncogent Inductive Arguments. A Cogent argument is an inductive argument which is strong and has true premises. Here truth of premises means complete truth as defined earlier. Any argument which fails to meet these criteria is Uncogent. Thus weak arguments and even strong arguments with false premises or false conclusion is Uncogent. But it may be noted that it may not be possible to always meet these conditions of Cogent arguments in real life situations. Therefore, the study of strong and weak arguments is more relevant for real life, especially in sciences, than limiting it to just cogent arguments.

4.8 COMPARISON OF DEDUCTIVE AND INDUCTIVE ARGUMENTS

We can compare the conceptual difference between the evaluation of induction and deduction as follows. Here we shall compare the status of the conclusion in each type of arguments assuming the premises are true;

		DEDUCTIVE ARGUMENT		INDUCTIVE ARGUMENT	
STATUS	OF	VALID	INVALID	STRONG	WEAK
ARGUMENT					
					

STATUS OF THE CONCLUSION ➔	IMPOSSIBLE TO BE FALSE	POSSIBLE TO BE FALSE	IMPROBABLE TO BE FALSE	PROBABLE TO BE FALSE
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The above table clearly shows the conceptual difference between deduction and induction in regard to their assessments. While in valid deductive argument if the premises are true, there is absolute certainty of the conclusion being true, on the other hand, even if the premises are true, in case of even a strong inductive argument, there is no such certainty, but only high degree of probability. The table also helps us to realize how truth or falsity of premises are related to good and bad deductive and inductive arguments.

Check Your Progress III

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

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

1. In respect of truth, what is the difference between a valid deductive argument and a strong inductive argument?

2. In a inductive argument with true premise what is the condition of “truth”?

4.9 A BRIEF NOTE ON INDIAN LOGIC

There are several approaches to logic in Indian Philosophy from its different schools. But none can be drawn as an exact parallel to either western deductive or inductive logic. In this account it will not be possible to give a detailed account of Indian Logic. We shall instead consider the Syllogism of the *Nyāya* School which is often compared with Aristotelian Categorical Syllogism, which we have largely dealt with in our discussion of Deductive Arguments. A *Nyāya* Syllogism, unlike Categorical Syllogism, has five terms. The arguments consist of typically 5 propositions. Let us begin with an example:

1. This hill has fire. (*pratijñā*)
2. Because it has smoke. (*hetu*)
3. Whatever has smoke has fire, e.g., an earthen oven. (*udāharaṇa*)
4. The hill has smoke, which is invariably associated with fire. (*upanaya*)
5. Therefore, this hill has fire. (*nigamana*)

In this argument, the first is the logical statement that needs to be proved, the second states the reason for the establishment of the statement, the third is universal concomitance along with example, the fourth is the application of the universal concomitance in the present case, and the fifth is the conclusion drawn from the preceding propositions. In this argument smoke is equivalent to middle term of Aristotelian Syllogism. In *Nyāya* Syllogism validity of arguments depends on the middle term, how it connects the major and minor term (here, fire and hill respectively). However, in order for the middle term to actually become a valid reason it needs to satisfy several conditions. When it fails to do so, it leads to fallacies. However, it may be noted that such fallacies are material fallacies and not formal fallacies. Also, when we talk about validity it is not confined to formal validity only like deductive argument.

The interesting fact is that in Indian Philosophy, inference is largely seen as integral part of epistemology. Inference is a means to arrive at true knowledge. Therefore, Indian Logicians are not particularly concerned about formal soundness and validity or the distinction between the two. Another important point is that, Indian Logic is both deductive and inductive in nature. That

is why the assessment criteria that are applied in the case of deductive arguments and inductive arguments in the previous sections are not properly applicable in case of Indian Logic.

4.10 LET US SUM UP

In this unit we have learnt about the concepts that are used to distinguish between good and bad arguments and how the value of arguments is related to the value of propositions.

Truth is a value of propositions and as such the premises of an argument can be either true or false.

We have learnt that in Logic the term validity exclusively applies to deductive argument only, an argument can be valid only when the relationship between premises and conclusion is such that the premises conclusively establishes the conclusion. Such relation can exist only in deductive argument. When a deductive argument fails to provide conclusive support to its conclusion, it is known as invalid deductive argument. So validity is purely a formal quality of an argument.

The validity or invalidity of argument is not effected by the actual truth of the proposition. We can find varying arrangement of true and false propositions in both valid and invalid arguments. However, the definition of validity is such that if the premises are actually true, then the conclusion cannot be false. Thus when there is a valid argument with actual true premises, it is termed as a sound argument. But we have also learnt focusing only on sound deductive argument does not serve the purpose of logic.

In case of Inductive arguments, we have learnt that the term “strong” and “weak” are used for evaluation of the correctness of the argument instead of “valid” and “invalid”. Because in inductive arguments the relationship between the premises and conclusion are such that the premises only provide probabilistic support to the conclusion. Thus in a strong argument if the premise are true, then it is improbable for the conclusion to be false. Probability is a matter of degree which depends on the level of support provided by the premise. When the probability of the conclusion being true is low, the argument is weak. A strong inductive argument with actual true premises is called a cogent argument.

Finally, we have also learnt that the complex relationship between truth and validity is not exactly applicable in case of Indian logic because Indian logic which is a complex mixture of deductive-inductive procedure.

4.11 KEY WORDS

Cogency: Cogency is a criterion used to further categorize Strong and Weak arguments. A strong argument with true premises is known as a cogent inductive argument. Strong arguments with false premise/premise and all weak inductive arguments are Uncogent arguments.

Soundness: Soundness is another criterion for categorizing deductive arguments. A sound argument is a deductive argument that is valid and all its premises are true. Valid arguments with false premise/premises and all invalid arguments are unsound.

Strength: The term strength is applied by some logicians to evaluate inductive argument as the term validity cannot be applied here. Depending on the probabilistic support provided by the premises to the conclusion an argument could strong or weak. Induction relies on the probability of the conclusion and probability is a matter of degree. An inductive argument is strong when it establishes that it is improbable for the conclusion to be false when the premises are true. When the premises fail to provide such support the argument is weak.

Truth: Truth is an attribute of a proposition and it refers to what is really the case. A proposition is an assertive sentence that can be either true or false. So “truth” and “falsity” are truth values of a proposition.

Validity: The term “validity” is applied to deductive argument only. An argument can be valid or invalid. An argument is valid if the relationship between its components is so that the premises conclusively prove the conclusion. When premises cannot support the conclusion conclusively, the argument is invalid. So, validity is about the logical connection between the propositions.

4.12 FURTHER READINGS AND REFERENCES

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4.13 ANSWERS TO CHECK YOUR PROGRESS

Answers to Check Your Progress I

1. An argument is valid if the relationship between its components are so that the premises conclusively prove the conclusion. So, validity is dependent on the logical connection between the propositions
2. Validity is not dependent on actual truth of propositions. In a valid argument the propositions are related in such a manner that if the premises are true, the conclusion cannot be false.

Answers to Check Your Progress II

1. Example of Valid argument with all false propositions

All birds are four-winged animals.

All cows are birds.

Therefore, all cows are four-winged animals.

2. Example of an invalid argument with all true propositions

Some men are adventurous.

Some men are writers.

Therefore, some writers are adventurous.

3. Sound argument is a type of valid argument in which the premises are true. By definition the conclusion of a sound argument is also true. One can thus say that sound argument is a valid argument with all true propositions. There are many valid arguments where premises and conclusion are false. Therefore, we can say that all sound arguments are valid arguments, but all valid arguments are not sound arguments.

Answers to Check Your Progress III

1. In valid deductive argument, if the premises are true, it is impossible for the conclusion to be false. In contrast, in a strong inductive argument, if the premises are true, then it is improbable for the conclusion to be false. Thus the truth of the premises in valid deductive argument gives absolute certainty of a true conclusion, but in case of strong inductive argument, the truth of premises proves only a probabilistic support to a true conclusion.

2. In case of inductive argument with true premises, the term “true” shall be taken in its fullest sense. The true premise, thus, should not miss or undermine any crucial information, so that no scope is left for a different conclusion than the intended one. Thus helps in reaching a high degree of probability a true conclusion.