Unit
6

The Nature and Subject Matter of Logic

LOGIC: An Introduction

Logic essentially has to do with reasoning of a particular sort, viz., inference. It is, in general, concerned with reflective thinking that is a thinking process which consists of going from one or more stated reasons, evidences or premises to a stated conclusion. Since every rational inquiry depends on logic, so it is very important that we know what follows from what. The gamut of reasoning is very big which attracts both psychologists and logicians alike; while the former is interested in the actual reasoning processes the latter is only interested in the correctness of the completed processes. Thus, the aim of logic is to make explicit rules and methods by which correct inferences or good thinking be distinguished from the incorrect ones rather than to study actual reasoning processes.

Logic provides meaning to any intelligible human linguistic discourse. It imparts and assesses the element of rationality in any completed reasoning process. While imparting rationality it enhances our stock of knowledge whereas in assessing rationality in its own technical way, it shows the utility or futility of any discourse. It is the backbone of any scientific literature. It is both a science and an art. It is science in so far as it provides consistency to what one believes. If there is no consistency in what one believes, then the entire talk of logic falls flat and the basic purpose of language, viz., communication is defeated. Further, it shares two prominent features with science which are as follows:

(i). It is an organized and systematic knowledge,

(ii). Its laws are universally applicable.

It is an art because its worth lies in winning strategies in the game of arguments. Awareness of logical principles and techniques leads to good thinking which helps us to distinguish fact from fancy. Either way logic is much more than a learning experience. Thus, logic can decidedly be defined as 'the science of inference'.

Inference is a psychological process that goes on in mind. It consists of going from one or more stated reasons or premises (sensory-evidence) to a stated conclusion of some kind. The linguistic counterpart of any inferential process is called an argument. This shift from a mental process to a linguistic counterpart is essential because most of what we believe, we have inferred. We express our beliefs through statements which are the building blocks of arguments. Thus, every argument reflects the underlying inferential process. When the passage from premises to conclusion is justified, the argument is called valid. When the passage is not justified, the argument is called invalid or fallacious.

From the above it is clear that the logician's primary interest is with arguments. His task is twofold:

(i) Finding criteria for distinguishing good from bad arguments, and

(ii) Discovering techniques for constructing good arguments.

Types of Logic

An argument is a set of propositions out of which one is the conclusion which is inferred and the rest are premises. In other words, an argument is a set of propositions barring one which is regarded as its conclusion. The following are examples of arguments:

(i) All birds are mammals and all sparrows are birds. So, all sparrows are mammals.

(ii) All communists are opposed to private property. All socialists are opposed to private property. Therefore, all socialists are communists.

A question arises as to what is the connexion between the premises and the conclusion. The reply to this question is that there is an evidential connexion between the two. The premises provide evidential support or justification for the conclusion. It is for the logician to evaluate whether the given evidence supports the conclusion or not. It is on the basis of this intended evidential relationship that we divide logic into two types, viz., deductive and inductive.

Every argument necessarily has two features. It has (i) a structure and (ii) a content. These two features can be best understood from the following figures.

P1	Evidence	P1	Evidence
P2	Evidence	P2	Evidence
Pn	Evidence	Pn - 1	Evidence
C: X is or is not the case.		C: X may be or may not be the case.	
(Fig - 1)		(Fig - 2)	

Figure 1 presents premises (P1 to Pn) as evidences leading to the conclusion as X is or X is not the case. Here, the evidential connection between premises and conclusion is based on necessity; thus the argument is deductive. In deductive argument the premises imply the conclusion. The deductive argument can be termed as valid or invalid when tested by various logical methods. Since deductive arguments are not concerned with the subject matter of the propositions which occur in it, they are not content-sensitive. They are actually those general moulds of thinking that are capable of generating infinite number of likewise arguments. That is to say, one valid argument-form is capable of generating innumerable likewise arguments. Validity as a logical virtue is preserved in all the subsequent

Note : P = Premise C = Conclusion

arguments. A valid deductive argument can never have true premises and a false conclusion; so it is truth preserving.

Figure 2 presents premises (P1 to Pn - 1) as evidences but leaving one instance out irrespective of the total evidential instances. Subtracting this single instance from the total number of instances makes the argument-form probable. Here, the evidential connexion between the premise and conclusion is based on probability; so the argument is inductive. It also shows the limitations of scientific laws which are widely confirmed workable hypotheses. These hypotheses, though open to revision, are always relative to the evidence. That is why scientific laws can never be absolute.

Finally, for our limited purposes we may say that in a deductive argument the premises are supposed to provide absolute guarantee for the conclusion, while in an inductive argument the premises are supposed to provide some degree of support for the conclusion. In deduction we ask for validity or invalidity of an argument whereas in induction 'probability' is all we can ask for. In deductive argument, the true premises lead to validity out of necessity. In inductive argument, there is always a 'logical gap' between the premises and the conclusion, making it probable even if all its premises are true. The use of both deduction and induction in science and ordinary life is essential and can by no means be underrated.

Sentence and Proposition :

A proposition is a sentence because like a sentence it is a meaningful arrangement of words. Every sentence, however, is not a proposition though every proposition is necessarily a sentence. A sentence is unit of language whereas a proposition is unit of logic. The sentence "Water is essential for living beings" is a proposition but the sentence "Get me a glass of water" is not a proposition. Sentences do not always carry truth values. There are sentences which are neither true nor false. For instance, "Close the door" is neither true nor false; it is because there is no belief or assertion in it. It is merely a request or an order to be obeyed. Similarly "What's the time?" is a request for the reply. Sentences such as interrogative, exclamatory, imperative, emotive are not propositions for we do not express judgments in them. Logic deals exclusively with propositions, and sciences both natural and social, also deal with propositions because they (sciences) deal with facts. Human knowledge is mainly constitutive of propositions.

Factual or informative sentences alone are propositions. Other types of sentences such as emotive, directive, interrogative, exclamatory and sentences giving commands and making requests are merely sentences; they are not propositions. A proposition carries truth value. It is believed to be true or false, and it is a description or assertion about facts. A proposition is true when it describes facts correctly and false when it states facts wrongly. The facts simply are, they cannot be said to be true or false. It is our belief in them which makes them true or false. We judge facts and give judgments. Proposition is an expression of these judgments.

In all arguments we make use of propositions which are said to be the building blocks of any argument. In logic 'proposition' and 'statement' are two terms which are used interchangeably. Proposition and statement are both sentences but all sentences are not propositions. A proposition alone is a unit of logical evaluation and not every sentence. In ordinary natural language we use sentences such as (i) Interrogatives- to ask questions, (ii) Imperatives- order someone to get things done, (iii) Exclamatory- to express feelings of wonder, fear etc. (iv) Declaratives- we assert or deny some particular state of affairs. It is only declarative sentences in the indicative mood which are called propositions or statements. For example, we have the following propositions:

(i) Taj Mahal is made up of white marble. (Affirmative)

(ii) Taj Mahal is not made up of white marble. (Negative)

Proposition has two prominent features which separate it from other sentences of language. They are as follows:

(i) A sentence is always language-specific whereas a proposition is not. A sentence could be a sentence from Bengali, Hindi or English but what it expresses is not language-specific. A proposition transcends the linguistic boundary in which it is framed. A proposition belongs to all languages.

(ii) A proposition alone is capable of assuming truth values. It can either be true or false. It cannot be both true and false at the same time otherwise it will lead to contradiction.

Truth and Validity :

The distinction between a sentence and a proposition is key to advance further in logic. Since propositions occur in arguments, does their truth or falsity make any difference to the validity or invalidity of the argument? While answering this question we must distinguish truth and validity.

The distinction between truth and validity is the fundamental distinction of formal logic. Truth is an empirical relation between the statement and what it asserts or denies about reality. Validity, on the other hand, is a logical relation between premises and conclusion. Some deductive arguments have a distinctive character which indicates that the premises are supposed to provide absolute guarantee for the conclusion. Such arguments are as follows:

1. A *syllogism,* in general, is an argument having exactly two premises and one conclusion. A *categorical* syllogism is a syllogism which makes use of propositions beginning with 'all', 'no', or 'some'.

   For example :

   Premise$_1$: All monarchs are dictators.

   Premise$_2$: Some monarchs are great scholars.

Conclusion: Therefore, some great scholars are dictators.

2. *Hypothetical syllogism* is a syllogism having a conditional statement as one or both the premises.

   For example:

   $Premise_1$: If surplus food grain is not distributed in time, it will be destroyed.

   $Premise_2$: Surplus food grain is not distributed in time.

   Conclusion: Therefore, food grain will be destroyed.

3. *Disjunctive Syllogism* is a syllogism having a disjunctive statement as one of its premises.

   For example:

   $Premise_1$: Either John is going to the party or Mary is going to the party.

   $Premise_2$: John is not going to the party.

   Conclusion: Therefore, Mary is going to the party.

Besides these the connexion between the truth and validity is by no means a simple one. There are some generic rules through which this relationship can be best understood along with examples. It will also help us to ward off some likely misconceptions about these notions.

1. True premises do not guarantee validity.

Example 1: Cows are mammals.

Dogs are mammals.

Therefore, dogs are cows.

2. A true conclusion does not guarantee validity.

Example 2: Cars are mammals.

Tigers are mammals.

Therefore, tigers are cats.

3. True premises and a true conclusion together do not guarantee validity.

See Example 2.

4. False premises do not guarantee invalidity.

Example 3 : Birds are mammals.

Cats are birds.

Therefore, cats are mammals.

5. *A false conclusion does not guarantee invalidity.*

   Example 4: Cats are birds.

   Dogs are cats,

   Therefore, dogs are birds.

6. *False premises and a false conclusion together do not guarantee invalidity.*

   See example 4.

Thus, while the truth of proposition and the validity of reasoning are distinct, the relationship between them is not entirely straight forward. When an argument has true premises and a false conclusion, it must be invalid. This is how we define invalidity. Although we can speak of valid and invalid arguments and argument-forms, it makes no sense to speak of valid or invalid statements. Nor does it make sense to call an argument as true or false. Validity and invalidity are properties of arguments; truth and falsity are properties of statements. Again, we should not be misled by true premises or true conclusion to suppose that that an argument is valid. Nor should we be misled by false premises or false conclusion to suppose that it is invalid. As a matter of fact, truth and validity are combined in the concept of soundness. An argument is sound if all its premises and conclusion are true, and its reasoning is valid; all others are unsound.

Logical Form

A question arises as to how we can be sure that in valid argument there could be no possible way for premises to be true and conclusion to be false. How can we possibly prove such a thing?

The answer to this question lies in the concept of form, pattern, or structure. To say that an argument could not possibly have true premises and a false conclusion is simply to say that it has a certain kind of form which does not admit of instances of such kind. It is the form of an argument, then, which determines its logical validity. Whether an argument is valid or invalid is determined entirely by its form. Let us examine the following example:

P1. All men are mortal.

P2. Socrates is man.

C: Therefore, Socrates is mortal.

What makes the above argument a valid argument has nothing to do with, Socrates, men or mortality. Rather each sentence in the argument exhibits a pattern , a logical form, which guarantees the truth of the conclusion given the truth of premises. More generally, the logical form of a sentence of natural language is what determines both its logical properties and its logical relations to other sentences. The logical form of a sentence of natural language is typically represented in a theory of logical form by well

formed formula in a logically pure language. In this language all meaningful symbols are expressions with fixed and distinct logical meaning. The arguments' validity is explained by the fact that premises formally entail (implies) the logical form of conclusion. Thus, the primary function of a theory of logical form is to explain a broad range of logical phenomena in terms of logical forms which it essentially assigns to sentences of natural language.

Use and application of Logic

Logic lies at the foundations of our life and is the foundation to every educational curriculum. But unfortunately its study is not included in most of the modern curricula. Money making skills and social skills have taken precedence over right thinking skills. This deviation in thinking has reached at such a sad state of affairs where the new generation refuses to think about others plight. They have become self-centred and insensitive towards the environment in which they live. Avoidance of logic has led to tragic consequences. Wrong political decisions are taken which affect millions of people. A criminal procedure system, which favours criminals rather than victims, has come up. This is the price society is paying for promoting the wrong notion that logic has something to do with mathematics and rest of us can reason in any way we like.

Logic, as we have learned, is the study of methods and principles used to distinguish correct from incorrect reasoning, so that we can refrain from making incorrect inferences. This, however, does not mean that those who have never studied logic cannot make correct inferences and arguments. Men had thought and argued generations before logic was discovered as a science and even today those who are ignorant of the rules of logic also reason and at times reason well. The only advantage of studying logic is that it makes somewhat easier to draw correct conclusions and avoid those linguistic traps which are pits of errors and bad reasoning. Just as a trained tennis player is better than an untrained one and is less likely to make mistakes, similarly, a good familiarity with logic helps us see the goodness or the badness in an argument. Lastly, its practical value cannot be overlooked. The study of logic provides certain techniques for putting to test the correctness or validity of all arguments. This is valuable because once errors are detected, they can easily be avoided.

Logic is one of the pillar stones on which mathematics rests, the other two being the set theory and the number theory. Mathematics deduces conclusions from self-evident truths or axioms and deduces further other conclusions from these. This brings order to the complicated abstractions of mathematics. Quantifiable sciences like physics, chemistry and engineering use deductive methods to draw definite conclusions from their axioms. Qualitative sciences like biology, physiology, medicine and also the social sciences like economics, sociology and psychology use logic by observing particular facts, comparing and classifying them and then seek to explain them by general laws. They adopt the inductive methods and their conclusions are more or less probable. Thus, all the sciences apply logic to their methods of investigations.

The enormous success of computers in recent times owes a lot to logic. The growth and development of computers is largely due to logic. The complex electronic circuits are designed to work primarily on binary (two-valued) logic. The relationship between computer architecture and logic is best seen in a new branch of logic called 'computational logic'. Further, a new three valued logic, viz., Fuzzy logic has given a new direction to the present technology regarding controls. It is used for developing sophisticated control systems. Fuzzy logic addresses control applications perfectly as it resembles human decisions with an ability to generate precise solutions from certain or approximate information. For example, let's take a fuzzy washing machine. A load of cloths in it and we press start button; now the machine churns automatically choosing the best cycle for washing. There are other kinds of logic which are very popular such as (i) Modal logic which is designed to express the logical structure of statements that contain modal terms like 'possible', 'necessary' and their variants. (ii) Temporal logic connected with the notions of time, (iii) Deontic logic is an attempt made to extend the arena of logic to certain kinds of reasoning in ethics. It deals with the ethical notions of permission, obligation and the like. Several deontic systems were developed but Nicholas Rescher's system is the most popular amongst all. (iv) Epistemic logic is an attempt to extend resonating to discourses which are connected with the notions of 'knowledge' and 'belief'. These are all specialized branches analysing different types of discourses which are beyond the scope of this book. Today logic is sited at the intersection of philosophy, mathematics, linguistics and computer science as it deals with the structure of reasoning and the formal features of information. Regardless of advances in its allied areas, logic thrives. Its techniques are applied to many different domains of reasoning, and its connections with linguistics and computer science have strengthened the discipline and brought it new applications.

Questions

1. Differentiate proposition from sentence. Give suitable examples in support of your answer.
2. Highlight the importance of logical form in evaluating arguments in logic.
3. Explain the difference between truth and validity.
4. Can a valid argument have false conclusion? If yes, how? Give reasons.
5. All true premises and a false conclusion always make a deductive argument invalid, Discuss.
6. Explain the relation between logic and mathematics.
7. Write a note on the advantages of studying logic.
8. What do you understand by inference? Differentiate deductive inference from inductive inference.
9. Name different types of logic besides the traditional Aristotelian logic.
10. Can the study of logic help in improving human society? Discuss.