STUDIES IN PHILOSOPHY AND SOCIETY

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VOLUME 1

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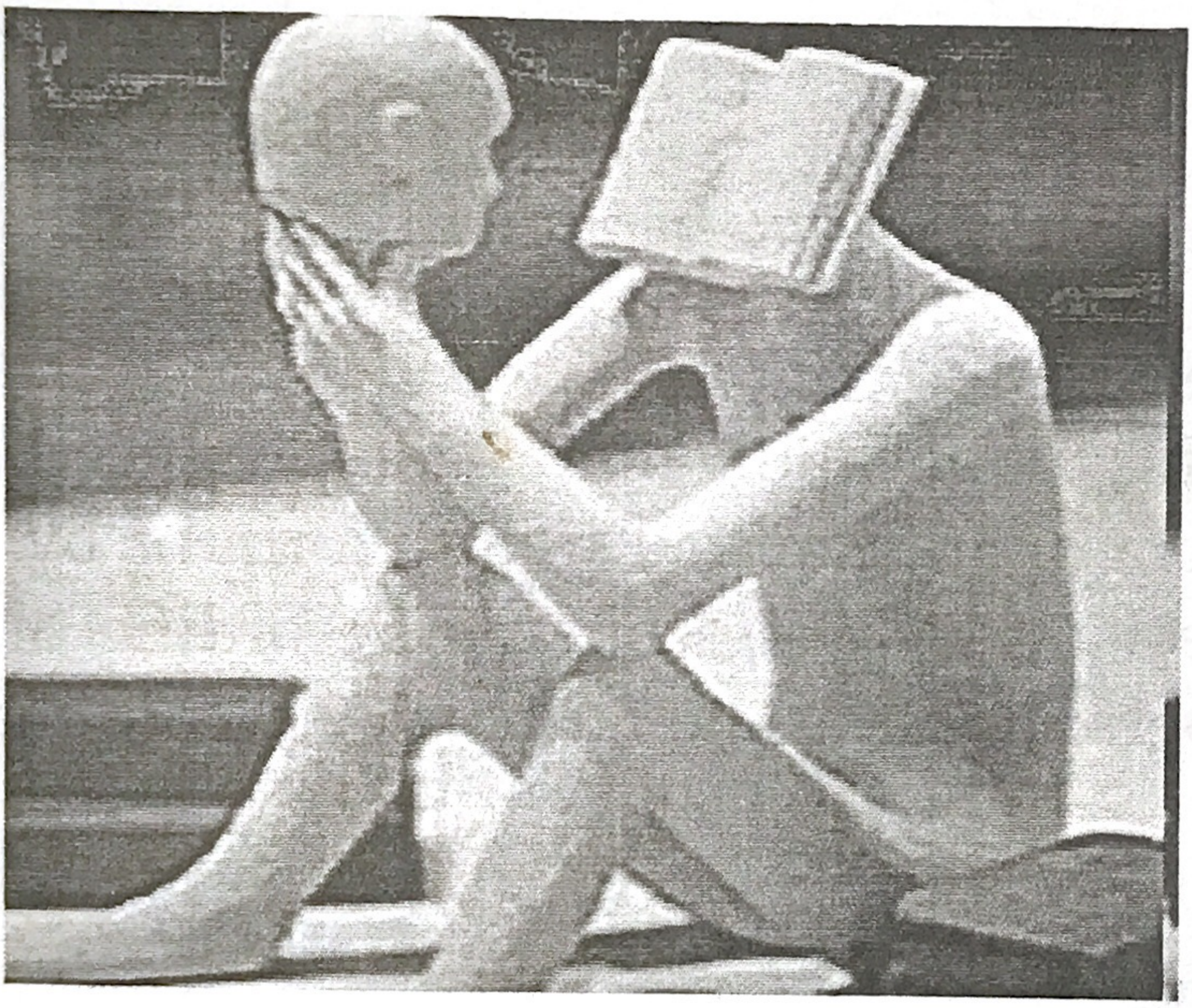

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10

Basics of Logic

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and
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Introduction

This chapter attempts to establish an understanding of the concept of logic. Since there is no unanimous definition of logic, we shall consider some definitions which will facilitate our development of a working definition. This will be followed by a historical trajectory of logic as a discipline, and thereafter, an exposition of the scope and subject matter of logic, as well as the laws of thought shall. The aspects or divisions of logic shall also be examined which include propositional calculus also known as truth-functional logic and Method of Natural Deduction.

This chapter shall also include an overview of arguments in logic. This will be done by means of some definitions which will facilitate an understanding of the concept of argument. Since arguments are constituted by sentences which are called propositions, a distinction shall be made between sentences in the ordinary sense and in the propositional sense. This will be followed by a quick glance at the components of arguments.

Inference, a term which denotes the relationship between the components of arguments, namely, premises and conclusions, shall also be considered. Also to be discussed in this chapter are: types and kinds of arguments, some instantiations of arguments, truth-value of propositions, validity and invalidity of arguments as well as sound and unsound arguments. A briefing on the usefulness of arguments to man shall also be given in this chapter. The chapter will close with a discourse on the relevance or value of logic as it applies to our daily living.

Meaning and Nature of Logic

Like Philosophy its mother-discipline, Logic has pluranimous definitions. However, we shall attempt an understanding of logic by looking at some definitions given by several scholars. Beginning with Irvin Copi, logic is the study of the methods and principles by which we differentiate good reasoning from bad reasoning and correct from incorrect reasoning (Copi, 1982:3). Raymond J. McCall defines logic as "the science and art of thinking" (McCall, 1952: XVII).

Although logic deals with issues like judgments, inferences, concepts, and proofs, its major aim is to establish a valid way of reasoning. This as a matter of fact accounts for why it is often referred to as "the science of correct reasoning" (Jimoh, 2014: 65). Logic may also be described as the science of the principles, laws, and methods, which the mind of man, in his thinking must follow for the secure and accurate attainment of truth. This implies that logic seeks to satisfy man's quest after truth by guiding his thought pattern by means of its laid down rules and principles (Jimoh, 2014: 65).

In a more technical sense, logic is a foremost branch of the discipline of Philosophy, which preoccupies itself with the study of the principles, techniques or methods employed in evaluating arguments and distinguishing between good and bad, valid and invalid, deductive and inductive as well as sound and unsound arguments (Offor, 2012: 3), as the case may be. By extension, logic is "the study of the principles and criteria of valid inference and demonstration." (Sainsbury, 2001: 9). These definitions upon critical analysis show that logic privileges a meticulous consideration of issues and seeks to ensure systematization of every discourse.

In furtherance, logic is the branch of philosophy which reflects upon the nature of thinking itself (Popkin and Stroll, 1969: 224). It attempts to answer questions such as: What is correct reasoning? What distinguishes a good argument from a bad one? Are there any methods to detect fallacies in reasoning, and if so what are they? Since philosophy is fundamentally concerned with making clarity out of the human thought, all its branches necessarily employ thinking in some fashion; the correctness or otherwise of this thinking will depend on whether or not it is in accordance with the laws of logic (Popkin and Stroll, 1969: 224). To this extent, it can be safely inferred that logic is pivotal to all the branches of philosophy, some of which are Epistemology, Metaphysics, Ethics and Aesthetics.

Logic can be comprehensively defined as the branch of philosophy which deals with the critical and systematic study, examination, interrogation and interpretation of the human thought pattern or reasoning process, for the sole aim of distinguishing between good and bad reasoning or correct and incorrect reasoning. In a more technical parlance, it is the study of the strength of the evidential link between the premises of an argument and its conclusion.

Historical Trajectory of Logic

Just as it is for all the other branches of philosophy, the historical development of logic is conterminous with that of philosophy, its mother-discipline. This is so because philosophers beginning from the ancient to the contemporary eras have always preoccupied themselves with critical thinking so as to arrive at diverse standpoints with regards to the problematics of our world. For instance, by means of critical thinking, which is very much central to logic, the Milesian/Ionian Philosophers (Thales, Anaximander, and Anaximenes), were able to give their distinct postulations regarding the primordial substance of all existents or ultimate principle of reality, as some philosophers would have it called.

However, while logic is as old as philosophy itself, the Western tradition has always ascribed the origin of logic to Aristotle (384-322 B.C.), who is acclaimed to have developed a system seen as a universal standard of thought that can be applied everywhere and at all times. This system of thought is what is called logic today (Jimoh, 2014: 65). Hence, according to the Western tradition, Aristotle was the first to develop logic as a discipline. This, he did by proposing the rules of reasoning that we now call logic (Lawhead, 2002: 72). This accounts for why he is often referred to as "an excellent formulator of logical reasoning".

Following the Western tradition, it can be said that prior to Aristotle, critical thinking, the very heart of logic was very much crude and somewhat uncoordinated. Aristotle established that the validity of reasoning does not depend on the content of arguments raised but on the structure or form of the arguments. For this reason, Aristotle's logic is widely known as "formal or deductive logic", as it deals more with the form of deductive arguments. It is also known as traditional logic as opposed to modern logic (Omoregbe, 1990: 105). Central to Aristotle's logic are the categories, predicables, and categorical syllogism, this being the most important aspect of his logic. A syllogism is an arrangement by which a conclusion is drawn from two statements, a major premise and a minor premise. The following argument is an instantiation of syllogism:

Every university student is educated (major premise)
Osaro is a university student (minor premise)
Therefore Osaro is educated (Omoregbe, 1990: 105).

OR

All Nigerians are Ghanaians
Aristotle is a Nigerian
Therefore Aristotle is a Ghanaian.

With the Aristotelian background of logic established overtime, logic as a discipline has experienced several modifications especially in the scholastic and medieval epochs as well as in the contemporary era. Philosophers across history modified the Aristotelian logic in order to adapt it to their own field of study. Some of these philosophers are: Ludwig Wittgenstein, Bertrand Russell, Alfred North Whitehead, Gottfried Leibnitz, Guiseppe Peano, Gottlob Frege,and so on. On this note, Aristotelian logic was at some point in time diagnosed with some certain neo-platonic elements as well as many Arabian ingredients (Boener, 1952: 5). In spite of all the modifications made with regards to the Aristotelian logic, it is very difficult if not out rightly impossible to talk of any form of logic that is completely devoid of Aristotelian elements.

Laws of Thought

Any good reasoning is expected to conform to a set of three logical principles that are called "laws of thought". Without due application of these laws, many logicians hold unwaveringly that intelligible and logically rational thinking is impossible (Oke and Amodu, 2006: 38). By way of definition, the laws of thought are "those principles or axioms which underline all human thinking processes and discourses" (Ekarika, 1985: 155). These laws which were propagated by Aristotle in a bid to evaluate logical claims are ably captioned thus: "Law of identity", "Law of contradiction or non-contradiction" and "Law of excluded middle".

Law of Identity

This law states that if any statement is true, then it is true and never false. In other words, every statement is identical with itself (Offor, 2012: 4). That is, any entity whatsoever is a mirror-like reflection of itself. This law finds instantiation in the following statement: "if it rains then it rains". This can be logically expressed as follows: "RƆR"; where 'R' represents "it rains", while 'Ɔ' (horseshoe,) represents a conditional (if...then.......). This is to say that "A" is "A"

Law of Contradiction or Non-Contradiction

This law posits that no statement can be both true and false at the same time (Offor, 2012: 4). In other words, no statement is capable of having dual truth-values; that is true and false at the same time, as this will amount to a sort of logical contradiction. For instance, the statement: "I am travelling to Ghana and I am not travelling to Ghana" is self-contradictory. Such self-contradiction is logically represented thus: "G• ~G"; where 'G' represents "I am travelling to Ghana", '• ' (dot, a conjunction) represents "and", while '~G' represents a negation, namely: "I am not travelling to Ghana", with '~', a curl, representing the negation. This is to say that "A" cannot be both "B" and Not "B"

Law of excluded Middle

This law asserts that any statement is either true or false. Hence, it will be logically absurd to claim that a statement is neither true nor false. There is no room for such middle ground (Offor, 2012: 4-5). The following is an example of a statement which follows the law of excluded middle: "either Paul wins the scholarship or John wins the scholarship". This is logically expressed thus: "P□J"; with 'P' standing for "Paul wins the scholarship", '□' (wedge, disjunction) standing for "either, or", and 'J' standing for "John wins the scholarship". Again this can be understood as Either "A" or NOT "A". In any possible world, either of the disjuncts must be true

Scope and Subject Matter of Logic

Like Philosophy, Logic is unlimited in its scope, as it stretches its tentacles to all disciplines which abound. This is to say that every discipline is guided by logic in as much as it is concerned with critical thinking or reasoning in some fashion. This fact is strongly affirmed by Andrew Uduigwomen who holds that logic is a multi-dimensional discipline that touches other fields of study, with a special affinity to Philosophy, Mathematics and Science (Uduigwomen and Ozumba, 1995: 154).

Regarding the subject matter of logic, we talk basically of thinking; that is the nature or pattern of human reasoning. This does not mean that thinking is particularly peculiar to logic. Psychology also interrogates thinking, but in a different manner. While Psychology is concerned with the actual process of thinking or reasoning, logic is concerned with the correctness of the completed process of reasoning (Jimoh, 2014: 65).

Aspects of Logic

Like every other branch of philosophy, logic also has divisions or subsets. However, it must be noted that the divisions of logic vary amongst scholars. Same also applies to the caption given to each division. Regardless of this, we shall align with a tripartite division of logic, which include the following: Informal or Material Logic, Formal or Structural Logic and Predicate Logic or Quantification Theory.

Informal or Material Logic

This aspect of logic is majorly preoccupied with examining the content of thoughts and expressions, with the sole aim of determining or assessing the truth value of the reasoning by means of certain rules and methods. Expressed differently, "Informal logic is concerned mainly with our everyday activities of making and evaluating claims, as well as detecting errors in reasoning" (Offor, 2012: 81).

Formal or Structural Logic

Specifically, this division of logic privileges an examination of the forms and structures of thoughts and expressions for the sole purpose of investigating their tenability or truth value. Again, Formal logic deals with the rational or correct structures of statements and arguments, which may be in natural or artificial language (Offor, 2012: 81). For Joel Kupperman and Arthur S. McGrade, Formal logic consists of inference whose justification can be treated systematically, by means of principles which can be readily applied to inferences on a wide variety of topics (Kupperman and McGrade, 1996: 17).

Predicate Logic or Quantification Theory

Central to this division of logic is the combination of both informal and formal logic in a bid to evaluating natural language. By implication, this aspect of logic is majorly concerned with translating sentences in everyday language into "a language consisting just of sentential connectives, terms, predicates, quantifiers and parenthesis" (Suppes, 1957: 43), all in a bid to assess its validity.

Logic and Arguments

More often than not, the word argument tends to have some negative connotations associated with it. Here, we talk basically of argument in terms of quarrel, dispute or disagreement. This is only a layman's definition. Before attempting a more technical definition of argument, it is expedient to note that the word argument as it is being used here does not mean: "a verbal duel, quibbling, shouting match, a quarrel or an altercation" (Lamm and Everett, 2007: 5).

Technically, the term argument refers to the articulation of our thinking process by which we present our claims to knowledge. It consists of one or more propositions referred to as premise(s), from which another proposition, referred to as conclusion is inferred (Jimoh, 2014: 67). Again, argument means "a statement that is backed by reasons or grounds to justify its acceptance or validity; with the hope that the statement will be regarded as a truthful or sound statement." (Ogbinaka, 2010: 81).

Argument may also be understood as a conclusion standing in relation to its supporting evidence, or a group of statements standing in relation to each other. An argument consists of one statement which is the conclusion and one or more statements of evidence called premise(s) (Oyeshile and Ugwanyi, 2006: 127-128). An argument can also be defined as a sequence of declarative sentences or propositions whereby one known as the conclusion is claimed to follow from the others called the premises, which are intended to provide sufficient grounds for the conclusion (Oladipo, 2008: 42-43). Furthermore, the term argument refers to "a group of statements, one of which (the conclusion) follows from others (the premises) which provide reasonable grounds or evidence for it" (Fadahunsi, 1999: 39).

Finally, an argument could also be defined comprehensively as a sequence, series, succession or collection of claim-establishing or declarative sentences which are either affirmative or negative, whereby some known as the premises constitute the reasonable grounds, evidence, proof or justification for another called the conclusion. It is therefore a system of producing list of statements, in which one is the conclusion and other(s) premise(s)

Sentences and Propositions

Since arguments are constituted by sentences which are called propositions, it is appropriate that a distinction be made here between sentences in the ordinary sense and in the propositional sense. In the ordinary sense, a sentence refers to a grammatically complete series of words consisting of a subject and predicate, even if one or the other is implied, and typically beginning with a capital letter and ending with a full stop.

Sentences are always part of a language, as they are used in all forms of verbal communication. A sentence may be interrogative, imperative, exclamatory, optative or declarative. Interrogative sentences are in the form of questions and do not necessarily contain epistemic claims or truth value. Imperative sentences, which are often in the form of commands meant to be obeyed also, do not contain any claim to knowledge. Same applies to exclamatory sentences, which are meant to express feelings or emotions, and optative sentences, which are meant basically to express individuals' wishes (Uduigwomen and Ozumba, 1995: 153). Unlike the others, declarative sentences are assertions or claims to knowledge (otherwise called epistemic or cognitive claims). These types of sentences are called propositions and are capable of being adjudged to be true or false, as they make assertions about the world. They are chiefly the concern of logic (Uduigwomen and Ozumba, 1995: 153).

From the above understanding of declarative sentences comes an idea of a proposition. Hence, "a proposition is a declarative sentence. Its major attributes are that it is either 'true or false'. It is not a 'linguistic object', it is the meaning that a sentence conceals in it and that it is confirmable." (Ndubuisi, 2004: 127).Thus, propositions are either true or false. But this is not the case with arguments, as they are adjudged not as true or false but as either valid or invalid and sound or unsound. A proposition can also be defined as a statement that affirms or denies something (Eboh, 1996: 55), or a sentence that expresses a fact (Ogbinaka, 2010: 83).

Therefore, a proposition is a declarative statement, and a declarative statement is a sentence that can be verified in order to establish its truth or falsity. "This is to say that any proposition in logic which is a declarative statement makes an assertion, that is, an assertion that such and such a thing is true or false." (Unah, 2001: 105-106). The following are examples of propositions:

a. Paul-Aloysius made a first class in his philosophical studies.
b. No man is an island of knowledge.
c. The moon is made of pounded yam.
d. Logic is a core branch of philosophy.

Components of Arguments/Some Instantiations of Arguments

Specifically, the word components as used here in relation to arguments simply refers to the parts of arguments. From our earlier understanding of the concept of argument, we can deduce that "an argument has two parts, namely, the premise-part and the conclusion-part" (Bello, 2000: 5) "Premises and conclusions are declarative sentences or propositions in an argument; they make specific epistemic claims. While the premises are the claims that provide the grounds for the conclusions, the conclusions are inferences drawn from the premises" (Adeniyi, 2000: 135). In other words, the premises of every argument constitute the reasonable grounds, evidence, proof or justification for the conclusion. There is no set number of premises which every argument must have, but there must be at least one (Copi, 1982: 409-410).

There are ways by which one can identify the premises and conclusions of arguments. One of such ways is by checking through the arguments for what most logicians call "premise and conclusion indicators". By "premise and conclusion indicators", we mean some words, expressions or phrases which indicate, point to, precede or usher in the premises and conclusions of arguments. Below are some premise and conclusion indicators:

a. Premise indicators: For, Since, Because, As, After all; Assuming that, Seeing that, Granted that, Here's why, This is true because, This is the case because, The reason is that, In view of the fact that, As implied by the fact that, As shown by the fact that, Given the fact that, In as much as, May be inferred from, May be deduced from, We say this because (Oladipo, 2008: 45), and so on.
b. Conclusion indicators: Therefore, Thus, Hence, So, Then, Accordingly, Consequently, That's why, This being so, It follows that, Which implies that, This entails that, This proves that, As a result, Which means that, From which we can conclude that, We may infer that, It becomes clear that (Oladipo, 2008: 45), amongst others.

With the term "premise and conclusion indicators" clearly understood, we shall now proceed by identifying the premises and conclusions of the following arguments:

a. Everybody interested in being on the team was at the meeting yesterday (premise). Barry was at the meeting (premise). So he probably was interested in being on the team (conclusion) (Oyeshile and Ugwanyi, 2006: 135-136).
b. All physicians are university graduates (premise), so all members of the Nigerian Medical Association must be university graduates (conclusion), since all members of the Nigerian Medical Association are physicians (premise).
c. All teachers are brilliant (premise). Jim is a teacher (premise). Therefore, Jim is brilliant (conclusion).
d. James is taller than Michael (premise). Michael is taller than Peter (premise). Therefore, James is taller than Peter (conclusion) (Unah, 2001: 106-110).
e. All computer literates read computer science in the

university (premise). Theresa is a computer literate (premise). Hence, Theresa read computer science in the university (conclusion).

It must be noted that there is no particular arrangement of premises and conclusion in a natural discourse. However, it must be emphasised that the premises need to appear before the conclusion in standard form.

Inference

The term inference describes the relationship between premises and conclusions. The word inference which is roughly synonymous with reasoning and reflective-thinking refers to the drawing of a conclusion from one or more premises which are either facts or general statements based on facts (Uduigwomen, 2003: 97). An inference may also be defined as the process by which some reasons are adduced for particular beliefs. For example: John is shivering because the weather is cold (Oyeshile and Ugwanyi, 2006: 128).

According to Ogbinaka, "an inference is a reasoning process, usually psychological or mental, whereby the human mind passes from given evidences in order to make judgement, infer or derive another or other evidence(s) which will be accepted as truthful or valid" (Ogbinaka, 2010: 82). Irvin Copi, defines inference as the process of transiting from the premises to the conclusions of arguments. This is to say that through inference, we are able to make propositions about the unknown using the known as foundation (Unah, 2001: 107), with the known being the premise(s) and the unknown being the conclusion. Given the above, we can define inference as it relates to arguments as the process whereby a claim-establishing, or declarative statement known as, conclusion is arrived at, reached or deduced from some other declarative statements known as premises.

For a broader understanding of the concept of inference, it is fitting that we look at its essential categorisations. Essentially, inference can be categorised into two: immediate and mediate inferences. Specifically, immediate inference refers to "a reasoning process in which an earlier position or proposition (premise) leads us (by material implication) to accept the validity of a new position or proposition (as its conclusion)" (Ogbinaka, 2010: 86). In other words, "immediate inference is the drawing of inference from only one premise." (Uduigwomen, 2003: 102). Below are some examples of immediate inference:

a. Lukas is a bachelor (premise). Therefore, he has no wife (conclusion).
b. John is taller than Paul (premise). It follows that Paul is shorter than John (conclusion).

From the above examples, we can observe that the conclusions are immediately implied and known from just only one premise given. This is not the case with mediate inference, whereby the conclusion is not known, or immediately implied from an earlier proposition (as its only premise), but requires a chain of interrelated premises (Ogbinaka, 2010: 86). This is to say that mediate inference involves taking recourse to the medium of second premise to justify the conclusion that is supposed to be drawn from the first premise. By way of definition therefore, mediate inference is "a reasoning process or argument in which two judgments are seen to be so related that a third necessarily follows them." (Uduigwomen, 2003: 99) Below are some instantiations of mediate inference:

a. Only qualified and certified teachers are allowed to teach at Our Lady's High School Effurun (premise). Charles is a teacher at Our Lady's High School Effurun (premise). Hence, Charles is a qualified and certified teacher (conclusion).
b. All human persons are rational (premise). Gabriel is a human person (premise). Thus, Gabriel is rational (conclusion).

In the above instances of mediate inference, we observe that the conclusion is not known, or immediately implied from the first premise; instead, recourse was made to the second premise for the justification of the conclusion, which is supposed to stem from the first premise.

Types of Arguments: Proofs and Refutations

Since arguments are constituted by propositions which are declarative statements that either affirm or deny something, we can talk of two types of arguments, namely, proofs and refutations. As a type of argument, proof is the demonstration of the necessary truth of a proposed conclusion from a set of true premises. Conversely, refutation is the demonstration of the necessary falsity of the proposed conclusion, given that the given premises are true (Oke and Amodu, 2006: 31).

In other words, giving a proof entails providing evidence to show that a particular conclusion is implied by or follows from certain premises. For instance, when the following premises: "Edwin is taller than Luke, and Luke is taller than James" are true, we can have the conclusion: "Edwin is taller than James". In this case, the proof or evidence for the conclusion "Edwin is taller than James" lies in the premises "Edwin is taller than Luke, and Luke is taller than James".

On the contrary, refutation has to do with providing evidence to show that a particular conclusion is not implied by or does not follow from certain premises. In this situation, we hold that the veracity or truthfulness of the premises necessarily implies the negation of the conclusion or that the negation of the conclusion follows from the premises. Hence, given that the premises of the above example, "Edwin is taller than Luke, and Luke is taller than James" are true, we cannot have the conclusion: "James is taller than Edwin". Here, the refutation of the conclusion: "James is taller than Edwin" lies in the premises: "Edwin is taller than Luke, and Luke is taller than James", because the premises disagree with the conclusion.

Kinds of Arguments: Deductive and Inductive

On the basis of the level of relationship (inferential connection) existing between the premises and conclusions of arguments, we can talk of two kinds of arguments, namely, deductive and inductive arguments. Specifically, deductive argument or inference as it is also called is that in which the premises provide total support for the conclusion, while inductive argument or inference is that in which the premises only provide probable support to the conclusion (Fadahunsi, 1999:40).

A deductive argument is a logical procedure where a specific statement is inferred from general statements, with the specific statement being the conclusion which necessarily follows from the premises which are general statements (Agbonkpolo, 2004: 46). This is not the case with an inductive argument where a general statement is inferred from a set of specific statements, with the general statement being the conclusion and the specific statements being the premises. Here, the conclusion, that is, the general statement is based on the probability that what is true of the sample of specifics (premises) is most likely to be true of the entire class (Agbonkpolo, 2004: 46). Below are some instantiations of deductive and inductive arguments:

Deductive Arguments

a. All ruminants have four-compartment-stomach (premise). Goats are ruminants (premise). Therefore, Goats have four-compartment-stomach (conclusion).
b. All professors are graduates (premises). Angela is a professor (premise). It follows that Angela is a graduate (conclusion).

Inductive Arguments

1. John is a graduate and has a white-collar job (premise). Benedict is a graduate and has a white-collar job (premise). Michael is a graduate and has a white-collar job (premise). Hence, most probably, all graduates have white-collar jobs (conclusion).
2. Patrick uses glasses and is intelligent (premise). Monica uses glasses and is intelligent (premise). Luke uses glasses

and is intelligent (premise). Thus, all persons who use glasses are intelligent (conclusion).

From the examples above, we can observe that, deductive arguments to a large extent, privilege a strong inferential connection between their premises and conclusions. Here, we talk of the premises giving conclusive reasons or evidence for the acceptance of the conclusion. In other words, having accepted the premises of a deductive argument, the conclusion as a matter of necessity, is also to be accepted. This does not hold for inductive arguments, which have weak inferential connections between their premises and conclusions; as their premises lack conclusive reasons, or only give probable support for the acceptance of their conclusions. Hence, it is not the case that having accepted the premises of inductive arguments, one necessarily has to accept the conclusion.

Truth-Value of Propositions

As earlier established, arguments are constituted by propositions. These propositions are either true or false. Specifically, a proposition is true when its epistemic claims or declarations are actually the case in reality. By implication, a proposition can be said to be false when its claims or declarations are not actually the case in reality. Take for instance the proposition: "All cows are birds" is false, as it is not actually the case in reality that cows are birds. But the proposition: "Catholicism is a subset of Christianity" is true, as can be observed in reality. It is apposite to note here that truth and falsity only apply to the propositions constituting an argument and not to the entire argument. Hence, it will be a misnomer to state that an argument is true or false, as only propositions can be said to be true or false.

Validity and Invalidity of Arguments

Unlike truth and falsity which are predicated on propositions, validity and invalidity can only be predicated on arguments. An argument is valid if its premises provide conclusive or enough grounds for the acceptance or truth of its conclusion (Offor, 2012: 23). This being the case, an invalid argument is that whose premises do not provide conclusive grounds or evidences for the acceptance of the truth of the conclusion. That is to say, an argument is invalid if its conclusion is not logically implied or entailed by the premises. We can equally speak of deductive argument as either sound or unsound.

Validity and invalidity are not applicable to inductive arguments but only to deductive arguments. Inductive arguments therefore are not adjudged as valid or invalid, but as strong or weak, correct or incorrect, reasonable or unreasonable, sound or unsound. They are appraised by the degree of probability which the premises provide for the conclusion (Uduigwomen, 2003: 38).

More so, it is appropriate to note here that the validity or the invalidity of an argument is not dependent on the truth-value of its constituent propositions, but on its form. In other words, an argument is not valid because its premises are true or invalid because its premises are false. Rather, an argument is said to be valid if it follows a deductive form; that is, if its conclusion is logically implied or entailed by the premises, and invalid if otherwise. In this light therefore, we can have a valid deductive argument with false premises. Below are some exemplifications of valid and invalid arguments:

Valid Arguments

a. All fowls are birds (premise). All birds have wings (premise). Therefore, all fowls have wings (conclusion) (Offor, 2012: 23-24).
b. All spiders have six legs (premise). All six-legged creatures have wings (premise). Therefore, all spiders have wings (conclusion) (Uduigwomen, 2003: 39).

The above arguments are valid because their conclusions necessarily follow from their premises. For instance, the propositions "all fowls are birds and all birds have wings", necessarily imply that "all fowls have wings". Similarly, the propositions "all spiders have six legs and all six-legged creatures have wings" imply that "all spiders have wings".

Invalid Arguments

a. All Nigerians are human (premise). Edward is human (premise). Hence, Edward is a Nigerian (conclusion).
b. All Nigerians live in Nigeria (premise). Richard lives in Nigeria (premise). Thus, Richard is a Nigerian (conclusion).

The above arguments are invalid because their premises do not necessarily imply or suggest their conclusion. For instance, the propositions "all Nigerians are human and Edward is human|" ·do not necessarily imply that "Edward is a Nigerian". Similarly, the propositions "all Nigerians live in Nigeria and Richard lives in Nigeria" do not necessarily imply that "Richard is a Nigerian". Richard could be a Ghanaian residing in Nigeria. It should be noted that the reasons for invalidity are generally not unconnected with the ideas of distribution of terms, quantity and quality etc which are very germane to the essence of validity

Sound and Unsound Arguments

Unlike validity and invalidity, the soundness or the unsoundness of an argument is largely dependent on the truth-value of its constituent propositions. This is to say that an argument is sound if its constituent propositions (premises and conclusions) are all true, but unsound if at least one of its constituent propositions is false. Some instantiations of sound and unsound arguments are given below:

Sound Arguments

a. All fowls are birds (premise-true). All birds have wings (premise-true). Therefore, all fowls have wings (conclusion-true) (Offor, 2012: 23-24).

b. All spiders have six legs (premise-true). All six-legged creatures have wings (premise-true). Therefore, all spiders have wings (conclusion-true) (Uduigwomen, 2003: 39).

Unsound Arguments

a. All cows have three legs (premise-false). All three-legged creatures have wings (premise-false). Therefore, all cows have wings (conclusion-false) (Offor, 2012: 24).

b. Patrick uses glasses and is intelligent (premise-true). Monica uses glasses and is intelligent (premise-true). Luke uses glasses and is intelligent (premise-true). Thus, all persons who use glasses are intelligent (conclusion-false).

Uses of Arguments

Man in his everyday endeavours, makes several claims regarding certain issues. Such claims which often take the form of arguments as a matter of fact are geared towards establishing every individual's standpoint with respect to any prevailing issue in various spheres of human existence and interrelations. Similarly, arguments are also used to resolve disagreements, persuade others to accept or reject certain claims, views, theories, positions and policies. By extension, arguments are also used to make certain issues clear, to solve problems, and to clear our minds over whatever appears to us as a puzzle (Oke and Amodu, 2006: 38).

At this juncture, we shall attempt to demonstrate the application of certain principles of logic to the examination of truth value of propositions and validity of arguments. This will be done under two processes namely propositional calculus and method of natural deduction.

Propositional/Truth Functional Logic

In Propositional/Truth Functional Logic, we shall examine a special type of Logic which deals with relationships between propositions using various statement operators or logical connectives which are truth functional in themselves. Logicians, in order to deal with such studies, introduce the use of symbols to represent propositions, terms and connectives. This is the hallmark of symbolic logic.

Students are required to show understanding of how statements are built up from atomic components into molecular propositions, using various kinds of statement operators. The truth value of a molecular proposition is largely dependent upon the truth function of its components parts which may be atomic proposition or even molecular proposition as the case may be. It is expected also that students would understand validity or invalidity of arguments through the truth table method. The aim of this is to demonstrate a demarcation between statements which are contingently true from those that are either tautologies or contradictory. Moreover, it shall similarly be shown under what conditions statements would become logically equivalent by the use of the truth table method.

A proposition could be either atomic (simple) or molecular (compound). A proposition is atomic if such statement does not have any other component part whereas a molecular proposition would have component parts which may be either atomic or molecular.

Examples:

(a) It is raining – atomic

(b) It is windy and it is raining – molecular

(c) If rain continues, and the river rises, then the bridge will wash out and road traffic to the town will be disrupted - molecular.

Note that (a) is an atomic proposition without a component part. (b) is a molecular proposition with 2 atomic propositions as its components. (c) is a molecular proposition but with molecular propositions as its component parts.

Logical Connectives

There are about 5 logical connectives.

(a) ~ (The tilde for the negation sign "not")

(b) . (The dot for the conjunction sign "... and ...")

□

(c) (The Vee or Wedge for the disjunction sign "Either ...or...")

□

(d) (The horseshoe for the conditional sign "If ... then...")

≡

(e) (The tripple bars for the bi-conditional sign "... if and only if...")

These connectives are used to build up atomic statements to molecular ones.

Symbolising Proposisitions

(1) Negation: To obtain negation of any proposition, the negation sign "~" is placed before the propositional constant e.g, "It is raining" can be negated as 'it is not raining' or 'it is not the case that it is raining' or 'it is false that it is raining' etc. Written as symbol, it is raining can be symbolised as R. Its negation will be ~"R".

(2) Conjunction: to obtain conjunction of two propositions, the connective (.) is placed between the conjuncts. Conjuncts are the component parts of a conjunction
Example: It is raining and it is windy R. W

(3). Disjunction. To obtain disjunction of two propositions, the disjunction sign, (□) is written between the disjuncts. Disjuncts are the component parts of a Disjunction
Example: Either it is raining or it is sunny.

R□S

(4) Material Implication or Conditional: To obtain the conditional of two propositions, the horseshoe sign is written between the antecedent and consequent. The component parts of a conditional are antecedents, where the statement comes before the conditional sign (□), and

implicate or consequent where the statement comes after.
Example: If it is raining then it is windy.

R ⊃ W

(5) Bi-conditional: To obtain the bi-conditional of two propositions, the tripple bars are written between the component statements.
Example: It is windy if and only if it is raining.

W ≡ R

Truth Table Method

The truth value of any molecular proposition depends on the truth conditional of its component parts. For our purpose, we shall examine the truth condition of five(5) kinds of molecular statement, which is normally expressed by True (T) or false (F). To obtain the truth condition of the component parts of a proposition, there is a need to identify how many possible levels of interpretation. This is achieved only by identifying how many statements are in the molecular proposition. Generally, the formula is 2^n where *"n"* signifies how many statements are involved. Therefore, a one statement proposition will have 2 possible levels of interpretation, whereas a two statement proposition will have 4 possible levels of interpretation. Evidently, a three statement proposition will have eight possible levels of interpretation and so on.

In truth table method, it is important to note that the truth value of a molecular proposition depends on the truth condition of its component parts. It is an attempt to determine the calculus (a formal system of symbolic expressions manipulated according to fixed rules) and the relationship that exist between two or more propositions. The determination of such calculus is persuaded by the truth condition of the component parts of the molecular proposition as well as the logical connectives. The decision-making procedure known as truth table method is guided by certain principles or rules, which are enunciated below.

For a proposition marked by a negation, it would be good to know under what conditions can the negation of a proposition be true or false.

Rule 1. The negation of a proposition is true where the proposition is false, and false where the proposition is true.

(1) Negation ~ P

~	P
F	T
T	F

Again, we may wish to know the condition under which a conjunction is true or false.

Rule 2. A conjunction is true where both conjuncts are true and false at every other levels of interpretation.

(2) Conjunction: P . q

P	.	q
T	T	T
T	F	F
F	F	T
F	F	F

Another question asked in truth functional logic is : when is a disjunction true or false?

Rule 3. A disjunction is true at every levels of interpretation but false where both disjuncts are false.

(3) Disjunction: P □ q

P	□	q
T	T	T
T	T	F
F	T	T
F	F	F

Rule 4. Concerning a conditional, it is established that a conditional is true at all levels of interpretation but false where the implicans/antecedent is true and implicate/consequent is false.

(4) Conditional: P □ q

P	□	q
T	T	T
T	F	F
F	T	T
F	T	F

Rule 5. A bi-conditional, also known as double conditional is true where both component statements are true and false together, and false where either is true or false.

(p ≡ q) ≡ [(p □ q) . (q □ p)] (The Bi-conditional p ≡ q is logically equivalent with its double conditional (p □ q). (q □ p)

(5) Bi-Conditional: P ≡q

T T T

T F F

F F T

F T F

The truth-table method can be used to decide the truth or falsity of propositions in various ways.

(1) Given that certain statements are already True, whereas some others are False.

E.g. If P, Q and R are true statements and S and T are False statements, which of the following statements are true?

a) ~ P □ Q (assign the truth values to propositions as stated by instruction)

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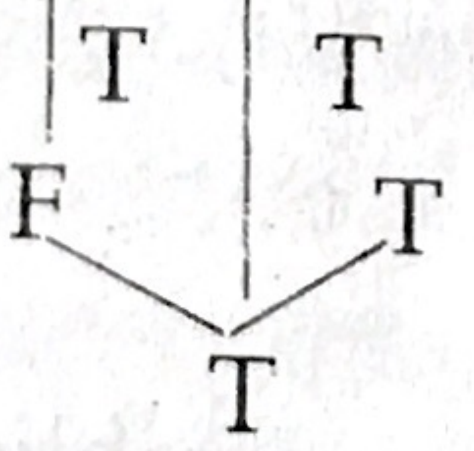
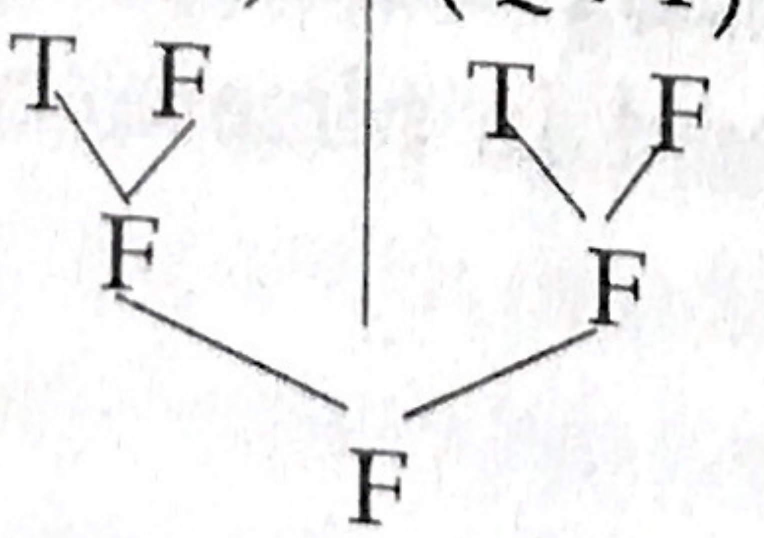
~ P □ Q



A True Statement

b) (P . S) □ (Q . T)



A False Statement

More examples:

(i) ~(S□T) . (~S□T)

(ii) P≡[(P . R) □S]

Check more examples from A.G.A. Bello Introduction to Logic

(1) Another significance of truth-table method is to decide which proposition is a tautology, contradiction or a contingency.

- A proposition is said to be tautologous if at all possible levels of interpretation, the truth value of the molecular proposition turns out True.
- A proposition is said to be contradictory if at all possible levels of interpretations, the truth value of the molecular proposition turns out False.
- A proposition is said to be contingently true if at all levels of interpretation, the truth value is a mixture of True and False.

E.g.

1) R□~R

T T F

F T T — A tautology

2) P.~P

T F F

F F T — A contradiction

3) P□q

T T T

T F F

F T T

F T F — A contigent truth

More examples

Using the truth-table method, determine whether the following propositions are tautologous, contradictory or contingents.

(a) A □ (B□~C)

(b) (A□B)≡(~B □~A)

(2) Again, the truth-table method can be used to decide whether or not two pairs of propostion are logically equivalent. Two pairs of propositions are logically equivalent if their bi-conditional turns out to be a

tautology.

E.g.

~ (P . q) ≡ (~P□~q)
F TTT T FTFFT
T TFF T FTTTF
T FFT T TFTFT
T FFT T TFTTF

These two statements are shown to be logicall equivalent.

More Examples

Determine by truth-table method whether the following pairs of propositon are logically equivalent.

(a) P≡(P□P)

(b) (P□q)≡(– q□~p)

(c) ~(P □q)≡(~P□~q)

(3) The last application of the truth-table method we intend to present here is how to determine the validity/invalidity of an argument. Write the argument in a horizontal line starting with the premise(s) and end with the conclusion. The premise(s) are separated by single vertical line while double vertical lines are used to separate the conclusion from the premise(s). Having re-arranged the argument, it is important to assign the truth condition to the propositions of the argument appropriately. With utmost consideration for the operation of the logical connectives, it is now important to inspect the horizontal row from the premise(s) to the conclusion with a view to determining if there is a level in which the premise(s) come out as true and the conclusion, false. One level of this analysis renders the argument invalid. However, if there is no such level, then the argument is said to be valid This fact proceeds from the assumption that a good argument requires that if the premises are true, the conclusion cannot but be true.

We now consider a few examples

P□q
q □r
∴p □ r

P □q	q □ r	p □ r
T T T	T T T	T T T
T T T	T F F	T F F
T F F	F T T	T F F
F T T	T T T	F T T
F T T	T F F	F T F
F T F	F T T	F T T
F T F	F T F	F T F

Valid Argument

It is important to inspect the argument in horizontal row to determine if the conclusion is false at any point where the two premises are true. The point here is for the two premises not to be true together whereas conclusion, false. Where either of the premises is true or false or even both false, and conclusion false as well, it does not render the argument invalid. Upon inspection, it is discovered that there is no level in which this rule is violated. Hence, it is a valid argument.

More exercises

With the help of truth-table, determine the validity or invalidity of the following arguments.

(a) P □ q

P∴ q

(b) P □ q
~ P

∴ q

(c) (P □ q) . (r □ s)

P □ r

∴ q □ s

(d) A □ B

B □ C

∴ C □ T

Method of Natural Deduction

It is important to equally note that the truth-table method at some point, becomes heavily burdened by its inability to adequately prove the validity of arguments composed of truth-functional statements. This is to say that the truth-table technique is not infallible and hence not foolproof. Consequently, an alternative method of proof of validity is hereby explored in a schema known as method of natural deduction. This method is pivotal to proof of validity of arguments following two principles.

(a) Any basic valid argument form is a prototype of any argument provided such argument shares the same form with the valid form.

(b) For every valid argument, its conclusion must be derivable or deducible from its premises either directly or indirectly (through some intermediate steps).

The attempt to explore alternative method of proving validity of arguments shall be limited only to rules of inference. Most books on logic seem to examine nine of these rules, and this makes it to appear as if the rules of inference are only nine. However, we shall attempt to examine ten of these rules. These rules are constructed upon the basis of Negations, Conjunctions, Disjunction and Conditionals in various combinations.

There are two basic valid argument forms constructed upon the basis of conjunction.

(1) Simplification (Simp)

P . q   P . q

∴ P   or   ∴ q

Given conjunction of two statements, either of the conjuncts can be inferred in a conclusion.

(2) Conjunction (Conj)

P

q

∴ P . q

Given any two propositions, the conjunction of these two propositions can be inferred in a conclusion.

Similarly, there are two basic valid argument forms constructed upon the basis of disjunction.

(3) Addition (Add)

P

∴ P □ q

Given the truth of any proposition, the disjunction of which it is a disjunct can be inferred.

(4) Disjunctive Syllogism (DS)

P□q   P□q
~P   or   ~q

∴ q   ∴ P

Given the disjunction of any two propositions, if the negation of either of the disjuncts is implied, then the truth of the other disjunct can be inferred in a conclusion. This is to say that the falsity of either of the disjuncts of a true disjunction implies the other disjunct.

Six basic valid argument forms are constructed upon the conditional.

(5) Modus Ponens (MP)

P□q
P

∴ q

Given the conditional of two statements, if the antecedent of the conditional is implied, then the consequent of the conditional can be inferred in a conclusion.

(6) Modus Tollens (MT)

P□q
~q

∴ ~p

Given the conditional of two statements, if the negation of the consequent is implied, then the negation of the antecedent can be inferred.

(7) Hypothetical Syllogism (HS)

P □ q

q □ r

∴ p □ r

Given a conditional statement, if the consequent implies a third propositon, then the antecedent also implies that third proposition.

(8) Constructive Dilemma (CD)

(P □ q) . (r □ s)

P □ r

∴ q □ s

Given the conjunction of two conditional statements if the disjunction of the antecedents of the two conditional statements is implied, then the disjunction of the consequent of the conditional can be inferred.

(9) Destructive Dilemma (DD)

(P □ q) . (r □ s)

~q □ ~s

∴ ~p □ ~r

Given the conjunction of two conditional statements, if the disjunction of the negation of the consequent is implied, then the disjunction of the negation of the antecedent can be inferred.

(10) Absorption (Absp)

P□q

∴ P □ (P . q)

Given a conditional statement, its antecedent implies the conjunction of the antecedent and consequent.

Having enumerated these ten rules of inference, it is extremely important to study them thoroughly so as to know their applications. We shall now attempt how they are used to construct proofs for arguments.

Examples

(1) P□(Q.~R)

(Q□R)□S

P /∴S

In constructing this proof, it is important to know that "S" is deducible from the lines of premises stated before it. So whatever rule permits us to derive "S" either directly or by way of intermediary, from the 3 lines above, we must explore it. The possible rules that may help us deduce a single proposition "S" from the premises above could be MP, SIMP,DS,. But in the case of the structure of the argument presented to us, it is most likely to be MP

1. P □ (Q . ~ R)
2. (Q □ R) □ S
3. P / ∴ S
4. Q . ~ R 1,3 (MP)

5. Q 4, Simpl
6. Q □ R 5 Add
7. S 2,6 MP

Lines 4-6 help us derive line 7(S) which is the conclusion from the premise.

(2) 1. (P □ Q) . (S □ T)
2. N □ O

3. (P □ N) . (S □ M) /∴ Q □ O

4. P □ Q 1 Simpl
5. P □ N 3, Simpl
6. (P □ Q) . (N □ O) 4,2, Conj
7 Q □ O 6,5 CD

Lines 4-6 help us to derive the conclusion in line 7 through an indirect process.

(3) 1. (A □ ~ C) □ B
2. A

3. (A □ ~ D) □ (R.S) /∴ (R . S) . B

4. A □ ~ C 2, Add
5. B 1, 4 MP
6. A □ ~ D 2, Add
7. R . S 3,6 MP
8. (R . S) . B 7, 5 Conj

Lines 4-7 help us to indirectly derive the conclusion through various rules.

For more excercises (refer to A. G. A. Bello Pp 221-223, then)

Relevance of Logic

One of the great relevance of logic to the human society is that, it helps to increase one's proficiency in reasoning. Logic aids the mind in arriving at knowledge of truth by providing us with principles which the mind must follow in order to secure truth and avoid errors. More so, logic helps us to secure consistency in reasoning (Uduigwomen and Ozumba, 1995: 154-155).

By extension, logic facilitates clarity, precision and tenacity in writing. It enables us to detect fallacies and inaccuracies in reasoning. It also adds some measure of consistency to our thought, feeling, speech, character and action (Uduigwomen and Ozumba, 1995: 154-155).

In furtherance, logic provides man with the principles for valid argument so that people can reach agreement where there are disagreements. This implies that consistency and orderliness in people's arguments will become possible and rationality would become devoid of sentiments (Agbonkpolo, 2004: 40). In addition, logic helps people to become sharp, discerning and articulate. It is an asset in the quest for truth because it teaches the rational process of correct inferential thinking (Eboh, 1996: 33).

Revision Questions

1. Attempt a definition of logic bearing in mind the pluranimous submissions of scholars.
2. Substantively discuss the laws of thought, scope and subject matter and aspects of Logic.
3. What do you understand by the term "argument"?
4. There abounds a relationship between the components of arguments, namely, premises and conclusions. This relationship as a matter of fact is ably accounted for by the term "inference". Discuss.
5. How beneficial or relevant is the discipline of Logic to man?

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