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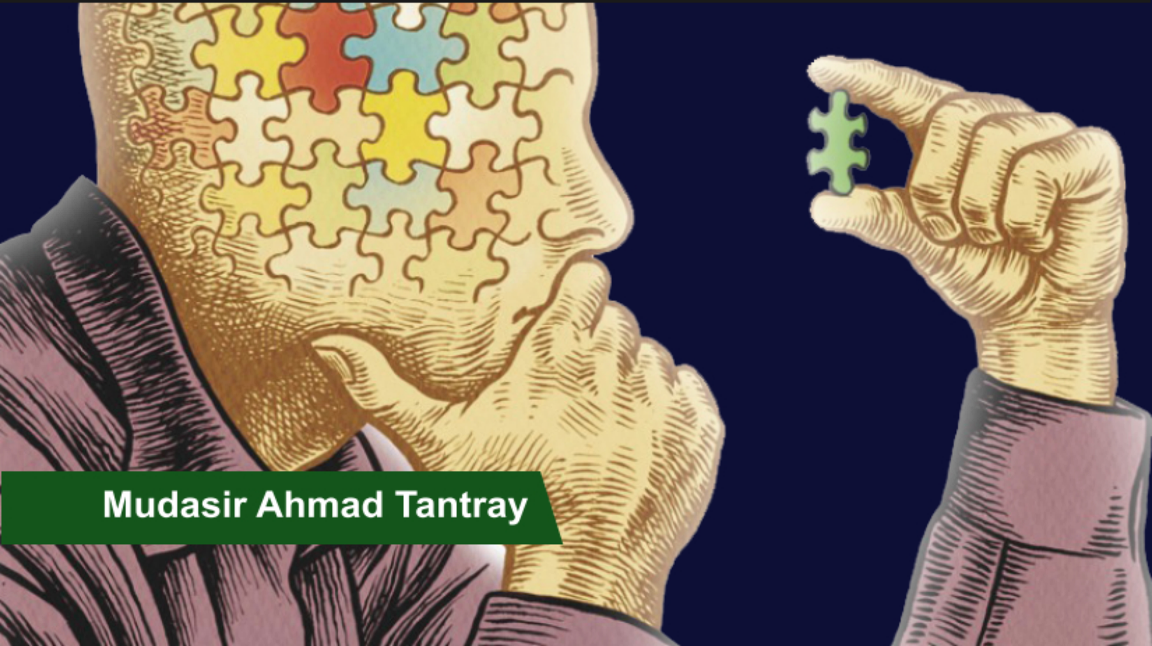
REMARKS ON LOGIC AND CRITICAL THINKING



Mudasir Ahmad Tantray

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Preface

This work is compiled for the students, research scholars, academicians, who are interested in logic, philosophy, mathematics and critical thinking. The main objective of this book is to provide basics or fundamental knowledge for those who have chosen logic as their subject in order to develop analytical and critical ideas. It has been primarily developed to serve as an introductory piece of work which includes explanatory notes on different courses like Inductive logic, Deductive logic, propositional logic, Symbolic logic, Quantification logic, Modal logic and Critical thinking. Besides this, it also includes illustrations in decision making and scientific research methods in logic. This book is mainly devised to clear fundamental problems of logic. It contains eight chapters which are simply described and elaborated.

First chapter deals with the description of propositions, arguments, terms, reasoning, and the classes. It is concerned with those statements which could qualify the criteria of reasoning. We have differentiated thinking from thought and different types of terms and class distribution.

Second chapter "Proposition" deals with the definition, qualification, types of propositions, and philosopher's contribution to proposition. In this we are concerned with the difference between proposition and sentence. This chapter further explains the role of proposition in the logical world.

Third chapter "Deductive logic" enlightens the world of deductive logic which includes the evaluation of deductive argument, valid and invalid argument as well as the strength and soundness of it. In this, I have explained syllogism, square of opposition, mediate inference, immediate inference, dilemma, figures, moods and Venn diagrams that represent the syllogism.

Fourth chapter "Inductive logic" deals with inductive argument, their probability and their weakness and strength. In inductive logic, we regard Mill's method of induction and scientific investigation, methodology and procedure as the basic tools and techniques for the evaluation of inductive arguments.

In the fifth chapter Mathematical logic (Symbolic logic), we will deal with mathematical or symbolic logic which includes the symbols and their representation i.e. negation, conjunction, disjunction, material implication and equivalence and their truth tables. Moreover, I have also described statements and statement forms along with argument and argument form.

Sixth chapter "Quantification logic" deals with quantification logic or predicate logic and the problems which I have described in this chapter are; quantifier: universal and existential and the square which represents propositions though quantifiers. In this chapter, I have also explained the approach in quantification logic which has modified and rectified Aristotelian logic though existential quantifier operators and universal quantifier operators.

Seventh chapter "Modal logic" deals with the modal propositions like, possible, impossible, necessary, contingent, actual, and non-actual propositions. In modal logic, I have described modal argument with symbols and square of opposition of model propositions. I have also defined modal propositions with reference to possible world and actual world.

Seventh chapter "Critical Thinking" is concerned with the orders of thinking i.e. first order thinking and second order thinking. Critical thinking is a skill to analyze arguments, decisions, identifying errors and it helps us in every sphere of life or in any field or sector. This chapter is very much important in this book only to enhance skills in students, research scholars, writers, professionals and counselors to reflect in decision making through logical reasoning. One more thing which I have portrayed in this chapter is the relation between Philosophy and critical thinking.

Sopore, J&K. M. A. Tantray

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CHAPTER - I

INTRODUCTION

Logic is the science of argumentation and reasoning. It is derived from the Greek word "Logos' which means reason or to think, so logic is the "art of reasoning" or "art of thinking. Human mind is always thinking and judging, to think is to judge. Whatever we think and reason, we express it in language and this language is only the means to logic. Traditionally logic is the branch of philosophy and sub-branch of Axiology which recognizes its three fundamental values; truth, goodness and beauty. Logic is the study of one of its value i.e. principle of "truth". Truth is the attribute of thought and thought is the crux of argumentation. Every thought is not logical, only those thoughts are logical that are expressed in the form of propositions. Logic is the science of truth and always protects us from committing fallacies. Logic is the epitome of philosophy. Without logic philosophy is incomplete and ambiguous. Logic is in our thoughts which we express in language. Aristotle is credited to be the founder of Logic. His own school was "Lyceum". He wrote his work "Organon" in Greek which when translated means "tool" or "instrument". While Zeno of Elea later on translated Organon and named it Logic. Thus, logic is the tool or instrument which tries to distinguish between "truth and falsehood", "correct and incorrect", "valid and invalid". Sometimes the science of logic means to explain things with clarity and validly which everyone can understand easily. Logic deals with premises, arguments and inferences and also tries to study inductive, deductive and adductive reasoning. Parmenides was the first Greek logician who proclaimed "what is contradictory to thought can't be real" which means what can't be thought, can't be and what can't be, can't be thought. He assumed that there is difference between sensation and reasoning (perception and thought). When we look towards earth, it assumes that it is in rest but in reality it is in movement, we look at sun which looks to us very small but in reality it is very big. We look at ether or space which looks empty but the logic behind it is that this space or ether is not empty it is made up of photons.

Proposition is the basic and fundamental unit of logic. Proposition and preposition are two different categories while one belongs to logic and other belongs to grammar. Preposition is a grammatical unit and proposition is a logical unit.

Proposition is defined as an assertion or declaration in which subject is either affirmed or denied. It is an assertion in which something is said of something. Which clearly indicates that the characteristics of proposition is that it is either true (1) or false (0). Proposition is also called statement or judgment or premise and in certain conditions 'sentence'.

Reasoning is of two types; inductive reasoning and deductive reasoning. While former is defined as the process of argumentation in which we proceed from particular instances to arrive at generalization and the latter is a type of reasoning in which we proceed from general truths to arrive at particular conclusion. Although reasoning, judgment, inference are used in logic synonymously. In logic we use statements or propositions which are basic units or presuppositions of the thoughts. Due to these propositions a logician would draw the conclusion equally for inductive and deductive reasoning. Propositions are either true or false and the arguments are either valid or invalid. In deductive reasoning, premises support the conclusion but in inductive reasoning premises do not support conclusion, conclusion asserts something new. Logic is a science which deals with thoughts. There are two aspects of thought that are of particular philosophical interest: its representation of things beyond itself, that is, its intentionality; and its movement of one representation to another in accordance with the laws of logic, that is, its rationality.1 Thoughts are expressed in the form of language. Language and thinking together constitute reasoning. "Thinking is of two stages: perception stage and processing stage; where perception stage implies how we look at the world (the concepts and percepts we form), the second stage of thinking is the processing stage (what we do with the perceptions that have been set up in the first stage. Logic can only be used in second stage since it requires concepts and perceptions to work up on. So what we can do with the first and second stage? We can depend only on chance, circumstance, induction, experiment, observation or mistake to change our perceptions or we can try to do something more deliberate" (Gregory, 1987). Our mind

[1]See Edward Feser, Philosophy of Mind, Oxford: One world Oxford, 2006, p. 113.

thinks in terms of propositions or categories. While arrangement, syntatics, capacity to act, and sequence are deductive to mind. What senses collects and mind interprets together constitutes perception. Reasoning is so important in philosophy that we need to give some special attention to the methods and techniques for distinguishing correct from incorrect reasoning. Even though reasoning and argumentation are activities, in which we all are engaged each day, because of its special importance in philosophy. Philosophers have refined over the years the principles of correct reasoning into the discipline known as logic. Perhaps it will clarify the goal of logic as a philosophical activity which differentiates the way of looking into the problems from the psychological nature.2

The use of reasoning to make decisions that can be characterized as an appeal to considerations that each person must address within his or her own mind, as a reflective person, with concentration on distinguishing the different issues and considering all the relevant points, including the consequences. The most important feature of reasoning however, is one we have not yet considered; seeing the connections and relations among all the relevant issues. How do some considerations contradict each other? How do some of the facts of the case strength one conclusion and weaken another? Given a certain set of beliefs or facts, what can be inferred from them? By focusing attention on all the considerations relevant to a particular decision, we become conscious of why we are doing something, and this is crucial part of what it means to be reasonable. A reasonable person is one who asks why, who looks for good reasons for doing or believing something, and who is willing, when asked to supply reasons why. One thing is true because other things are true; some things become reasons why we should believe other things. The study of such connections is the study of logic, and logic in connection with reflection is the primary search tool of philosophy. Science is also based on an appeal to reason, but the scientist unlike the philosopher can also appeal to empirical facts. A scientific hypothesis is based on

[2] The goal of psychology and philosophy towards logic are same but they differ in methodology, interpretation, and propositions.

reasoning. Further inductive reasoning and deductive reasoning are illustrated as:

Inductive reasoning:

Plato, Aristotle, Kant are human beings

Plato, Aristotle, Kant are mortal

Therefore, all human beings are mortal.

Deductive reasoning

All chilies are bitter

Peppers are chilies

Therefore,   Peppers are bitter

Lay-man, s argument and logician's argument

Does mind exists? Of course, it does not! We can, t see it, touch it, or locate it?

Logician's argument

All bodies which exist are perceivable.

Mind is not perceivable.

Therefore, Mind is not a body which exists.

What is Reasoning

The object of reasoning is to find out, from the consideration of what we already know, something else which we do not know. According to Charles Sanders Pierce, Reasoning is a kind of thinking that involves making inferences, or drawing conclusions. Different aspects of reasoning have been studied by different academic disciplines including Psychology, Artificial intelligence, computer science, Mathematics, Linguistics, and Philosophy. Although they ask very different questions, Logic overlaps with Psychology as the study of a type of mental activity. Psychology takes up questions such as why humans reason, what leads us to successful reasoning or causes us to fall into error, and whether other types of creatures reason. Logic aims at understanding when our reasoning is valid. Its primary concern is whether or not our inferences rest on solid ground.

Logic overlaps with Linguistics because our reasoning is expressed in and through language, in words, in statements and sentences. Because reasoning presents itself through definable patterns that can be symbolized and manipulated by applying formal rules, Logic resembles with Mathematics. Logic is a branch of Philosophy because it was among the ancient Greek philosophers more than 2500 years ago that Logic was first explored in a systematic way as a study of argument and reasoning. The Greeks first raised many of the questions that logicians continue to grapple with today, and the work of the philosopher Aristotle provided the first formal analysis of reasoning. His studies of Logic were the standard for the discipline for over two centuries. Reasoning has value because it moves both ideas and policy. At its best, the power of reasoning is due to the clarity and efficiency it lends to solving problems, discovering new truths, persuading others, and clarifying what we believe and why we believe it.

Definitions of Logic

Dewey and Stabbing: Reasoning is a reflective thinking.

Aldrich: Logic is art of reasoning

Thomson: The science of laws of thought

Hamilton: Logic deals with only formal laws of thought

Arnold: The science of the understanding in the pursuit of truth.

Averroes: Logic is the tool for distinguishing between the true and false.

Scope of Logic

Following are points which highlights the scope of Logic

1. Logic is the science which distinguishes between true and false
2. Logic deals with various intellectual processes like; thinking, reasoning, understanding, reflection and judgment.
3. Logic studies various processes of reasoning to evaluate evidence

4. Logic studies inductive, deductive and abductive reasoning.
5. Logic studies about premises, inferences, propositions and arguments
6. Logic deals with, how to avoid fallacies and develop critical thinking.
7. Logic checks the validity and invalidity of various arguments.
8. Logic evaluates language of quantifiers and modal system
9. Logic studies certain mathematical symbols
10. Logic studies propositions, their truthfulness and strength.

Sentence

Sentence is grammatical unit belonging to a specific language. All sentences are not propositions but all propositions are sentences. In some conditions sentences are used as propositions only that they do have truth values, otherwise not. The questions viz. how old are you? Who is your father? Who are you? Are you a politician, **commands:** (shut up, go there, get out) and **exclamation:** (what a rose, oh my God) are sentences that do not have any truth value, as they do not assert or deny anything.

Characteristics of sentence are:

1. The grammatical sentences may be in imperative, disjunctive, exclamatory or indicative mood.
2. Grammatical sentences may express wishes, orders, surprise or facts.
3. Every grammatical sentence must not possess subject, predicate and copula.
4. A grammatical sentence may have multiple subjects and predicates e.g. Plato and Aristotle are great philosophers. Socrates is a wise man and a Greek philosopher.

5. A proposition must state the quantity and quality of proposition but this is not necessary in case of grammatical sentence.
6. Every sentence cannot uphold the status of proposition. Only those sentences can become proposition that fulfills the criteria of proposition.
7. The fundamental quality that can make sentence a proposition is it's truth value (T or1, false or 0)
8. The sentences like ‘Hello, shut up, get out, silence please, oh my God are without truth values.

Proposition

A proposition is a logical unit. Proposition is an assertion in which subject is either affirmed or denied. Or we can define it as the assertion in which something is said of something. All propositions are sentences because what proposition asserts, it expresses it in sentence. The attribute of proposition is that it is either true (1) or false (0). Propositions thus differ from questions which can be asked, and from commands which can be given and from exclamation which can be uttered. None among these can be asserted or denied. Truth and falsity apply always to propositions, but do not apply to questions, commands and exclamations. Examples of propositions are:

Rose is red (where rose is subject, red is predicate and ‘is’ is copula)

Man is mortal (where man is subject, ‘is’ is copula and mortal is predicate)

Triangles have three angles (where triangles is subject, have is copula and three angles is predicate).

Indians are Asians (where Indians is subject, are is copula, and Asians is predicate).

Characteristics of propositions

1. Propositions are always in indicative or declarative mood.
2. Propositions are factual.

3. Propositions contain three terms; subject, predicate and copula.
4. Propositions must state quantity of the subject and quality of the proposition.
5. Propositions are material of our reasoning e.g. “chilies are bitter” is a proposition.
6. Every proposition is in the form of S is P.
7. Propositions are the universal presuppositions of our thinking or judgment.
8. Multiple subjects and multiple predicates make the proposition multiple e.g. whole numbers and natural numbers are integers. Descartes and Spinoza are rationalists (Descartes and Spinoza are two subjects) makes two propositions; Descartes is a rationalist, Spinoza is rationalist, but this thing is not possible in sentence; multiple subject and multiple predicate can’t make the sentence multiple.

Types of propositions (Aristotle’s classification of proposition)

Aristotle suggests that all propositions either affirm or deny something. Every proposition must be either a positive or negative.

Following are the types of proposition:

1. **Simple proposition:** a simple proposition is a type of proposition which contains only one subject and predicate. E.g. earth is round (E is R), mosquito is an insect (M is I). Generally, S is P.
2. **Compound proposition:** a compound proposition is a type of proposition in which, there we find more than one subject and predicate. E.g. Bananas and oranges are fruits (B and O Are F), Thales is first cosmologist and mathematician (T is C and M)

Proposition according to relation

Categorical proposition: A categorical proposition is a type of proposition which asserts without any condition. It merely affirms or denies some fact. E.g.

Water is liquid

Constitution is written.

Crows are black

Hypothetical proposition: Hypothetical proposition is a type of proposition which asserts with conditions. It is sometimes called conditional proposition.

If water is mixed with milk, then it cannot be called water.

If God is just then he will punish sinners.

If he is Indian, then he is Asian

If it fires, then it burns.

If he is idealist, then he is philosopher.

Disjunctive proposition: The proposition which is in the form of "either …. or" is called disjunctive proposition. E.g. either he is a poet or a philosopher, either she is beautiful or an ugly.

God is either just or unjust.

Disjunctive proposition: Disjunctive proposition is a type of compound proposition which is in the form of "Either.... Or". When two propositions are connected with the connective "either…or" we called it disjunctive proposition. E.g.

Either she is beautiful or an ugly

Either Plato is an idealist or a Rationalist.

Water is either colorless or quenches thirst.

Proposition according to Quantity

Universal proposition: In this proposition what is asserted applies to whole of the subject. All members are included in it. This proposition starts with the prefix "All" and "No" but also the character of proposition is determined from context e.g. All politicians are corrupt; no man is angel. God is substance. Universality is the quantity of the proposition.

Particular proposition: In this proposition what is asserted applies to only some members of the subject. Both the subject and predicate have some members common. This proposition starts with the prefix "some" which mathematically means "at least one". The prefix 'some' in propositions designates that they are particular propositions. E.g. some apples are green, few people are honest, and some girls are not studious.

Proposition according to Quality

Affirmative proposition: Affirmative proposition is a type of proposition in which affirmation is being made about the subject or we can say that what is affirmed of the subject. E.g.

Plato is a Greek philosopher

Fire is hot

Apples are red

Stone is a hard substance

Negative proposition: Negative proposition is a type of proposition which subject is denied. Negation is made of the subject. E.g.

Aristotle is not an idealist.

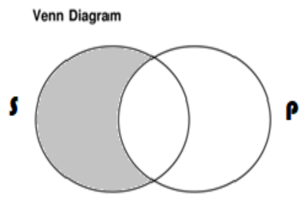
Fire is not hot

Apples are not red

Stone is not hard substance

Proposition according to Quantity and Quality

Universal Affirmative proposition: Universal affirmative proposition is a type of proposition in which the members of the class of subject term are contained in the members of the class of predicate term. In this type of proposition something is affirmed of the whole of the subject. There is an inclusion of the subject term in the predicate term. This proposition is always in the form of (All S is P). It is denoted by "A". Universal affirmative proposition is written in a Venn diagram as:



The examples of Universal affirmative proposition are

All crows are black

All rocks are hard

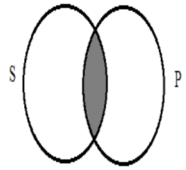
All animals are creatures

All philosophers are thinkers

Universal negative proposition: Universal negative proposition is a type of proposition in which the members of the class of subject term are excluded from the members of the class of predicate term. In this type of proposition there is exclusion between the subject term and predicate term. Here something is denied of the whole subject. It is always in the form of (No S is P). It is represented by “E”.

No birds are insects, No men are flying, No philosophers are angels, No negations are affirmations are examples of E proposition.

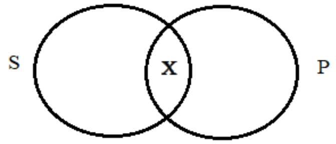
Universal negative proposition (No S is P) can be represented as:



Particular affirmative proposition: Particular affirmative proposition is type of proposition in which something is affirmed of the part of the subject and there is a partial inclusion. In this proposition some members of the class of the subject term are common with the members of the class of the predicate term. It is called particular because of the prefix “some”. It is always in

The form of (Some S is P). It is denoted by the letter “I”, that is why they are called ‘I’ type propositions. For example,

Some students are hard workers
Some ideas are innate
Some philosophers are idealists.
Some flowers are red.
Particular affirmative proposition (Some S is P) can be represent by Venn diagram as:

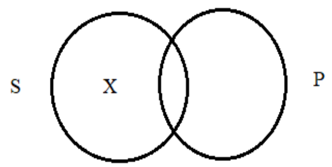


Particular negative proposition: Particular negative proposition is a type of proposition in which at least one member from the class[3] of subject is excluded from the all members of the class of the predicate. Here subject is partially denied. It is

[3]The collection of all objects that have some specified characteristics in common.

always in the form of (Some S is not P). It is represented by the letter “O”, and are called ‘O’ type propositions. In this

Proposition there exists some common elements between the subject and the predicate term but these common elements are excluded from the predicate term. For example, some socialists are not communists. Following are the examples of O type proposition; some flowers are not red, some rocks are not igneous, some apples are not sour, Particular negative proposition can be represented in a diagram as:



Thus the propositions A, E, I, O are called categorical propositions. While A is called universal affirmative proposition, E is called Universal Negative, I is called Particular affirmative and O is called Particular negative.

Standard form categorical propositions

Proposition Form	Name and Type	Example
All S is P	A-universal affirmative	All stones are hard substances All men are Mortal All men are Mortal
No S is P	E-Universal negative	No criminals are good citizens No Men are Mortal No Rational Numbers are Integers
Some S is P	I-Particular negative	Some chemicals are Poisons Some Men are Mortal Some Even Numbers are Prime
Some S is not P	Some S is not P	Some chemicals are not Poisons Some Men are not Mortal Some Numbers are not Odd

Proposition according to Modality

Problematic Proposition: Problematic proposition is a type of proposition which asserts what is possible and what is impossible. E.g. “A Novel can be larger than a dictionary” and “this may be Poison”. These are problematic Proposition.

Assertoric Proposition: Assertoric proposition is a type of proposition which what asserts depends on the existence and non-existence. Or which states that what is actual is called assertoric proposition. E.g. “Pacific Ocean is larger than Atlantic Ocean” and “this is Poison”

Apodictic Proposition: Apodictic proposition is a type of proposition which what asserts depends on the necessity and contingency of the propositions. Or which states that what is necessary is called Apodictic proposition. A-priori truths are necessary truths. e.g. “142 is larger than 37” and “Every effect must have a cause”, is apodictic proposition.

Analytical Proposition: An analytical proposition is a type of proposition in which predicate term is contained in the subject term. In this proposition predicate adds nothing new. E.g.

All red roses are red

All bachelors are unmarried

All triangles have three sides.

All bodies are extended.

Synthetic proposition: Synthetic proposition is a type of proposition in which predicate term is not contained in its subject term. in a synthetic judgment, the predicate adds something new. For e.g.

All roses are red.

All bachelors are happy

All bodies are heavy.

Term

A term is defined as the set of objects which designates the class or it is the element of the proposition. All terms are words but all words are not terms. A proposition consists of three terms; subject term, predicate term and copula term.

Types of terms

Subject term: The term or class about which the proposition asserts (affirms or denies) is called subject term. e.g. in the proposition “Man is Mortal”; Man is the subject, Rose is Red; Rose is the subject.

Predicate term: That about which something is said or asserted is called predicate term or predicate class. In the proposition “Man is Mortal”, Mortal is predicate, Rose is Red; Red is the predicate.

Copula term: Copula term is type of term which connects two terms; subject and predicate. The word copula is derived from the word copule, which means to join. Copula is always in the verb form i.e. ‘to be’, ‘is’ ‘are’ etc. e.g. Gita is a Holly Book. In this proposition, ‘Is’ is a copula term and in proposition “Thinkers are Philosophers”; “are” is a copula term.

Term Distribution

There are four types of categorical propositions and law of distribution states that whether subject and predicate term distributes or not. In propositions A, E, I, O. distribution occurs in two cases.

Case-1: All the members of the class of subject should be included in the members of the class of predicate. (S is included in P).

Case-2: No member of the class of the subject should be included in the members of the class of predicate and vice-versa. (S is excluded from P and vice versa). We can also write it as “All members of the class of subject term should be excluded from the members of the class of predicate”.

Thus no distribution is possible for partial inclusion and partial exclusion. Distribution refers to four categorical propositions A, E,I, and O.

Universal affirmative proposition: only subject term distributes.

e.g. All crows are black:

In above example only the term crows are distributed and black is not distributed because all black things are not crows.

Universal negative proposition: Both the subject and the predicate term distributes.

e.g. No Angels are Humans:

In above example both the terms Angels and Humans distributes, because neither any angel is human nor any human is angel.

Particular affirmative proposition: neither subject term distributes nor predicate distributes.

e.g. some cows are white

In above example neither term distributes because for some members, distribution is not possible.

Particular negative proposition: Subject term is not distributed but the predicate term distributes.

e.g. some oranges are not ripe.

In above example subject (oranges) is undistributed as there exists some oranges but predicate distributes because there is an exclusion of oranges from the class of ripe things. When there is full exclusion or inclusion then distribution occurs.

Laws of Thought

Aristotle formulated three laws of thought. These three laws of thought are fundamental presuppositions of thinking. They are called universal postulates of reasoning. These three laws of thought are as follows.

1. Law of identity
2. Law of non-contradiction or contradiction
3. Law of excluded middle.
4. Laws of sufficient reason (added by modern German philosopher, Leibnitz).

Law of Identity

This principle states that if any statement is true, then it is true. The law of identity may be stated as follows

Whatever is, is, whatever is not, is not.

Everything is identical to itself.

Everything remains the same throughout.

If any statement is true, then it is true.

A is A. ($P \supset P$).

This law of thought can be expressed as follows;

Whatever is, is:- it has been pointed out by the author of Bhagavad-Gita, that whatever exists cannot be non-existent and whatever is non-existent cannot be existent. In other words, whatever is, is, whatever is, is not.

Each object is according to itself: it means that everything is identical. Each object should be taken as it is. For example, A glass is a glass and a fire is a fire then something else. If we do not stick to their fixed meaning and take each to be identical with itself, we cannot use them for the purpose of thinking. A man is a man, it may be tautology and yet one means by it that the human nature is like human nature and different from the nature of a thing, animal or God. In identity things remains same at any two moments.

Principle of non-contradiction

It is named law of non- contradiction by Hamilton. It is also called law of contradiction. This law states that 'no statement can be both true and false'. The law of contradiction has been expressed as 'A cannot be B and Not-B at the same time. In other words, 'a thing cannot be both exist and non-exist at the same time. If you say that She is beautiful, it cannot be said that he is she is not beautiful at the same time. one cannot assert that water is hot and water is cold at the same time unless the words in and out are taken in some special sense. According to Hamilton a thing cannot be white and non-white at the same time.

Thus law of contradiction may be expressed as

A is not Not-A

A cannot be both B and Not-B at the same time, in the same sense and at the same place.

Nothing can be and not be at the same time

Principle of excluded middle

This law states that everything thing can either be or not-be i.e. every statement is either true or false. It is named exclude middle as in it there is no third or middle course.

According to this law anything must be either true or false. A or not-A. for e.g. A piece of toffee can either be sweet or not-sweet. The law of excluded middle asserts that two contradictory terms cannot both be false of the same object. i.e. one must be true.

Thus the law of excluded middle may be expressed as

Everything is either A or Not-A.

A piece of chalk is either white or non-white.

A is either B or Not-B.

Law of sufficient reason

This law states that nothing happens without a reason why it should be so, rather than otherwise. Whenever there is any change there is always a sufficient reason to account for this change and every event must have a cause and Every theory is improvable.

Newton saw an apple falling on the ground and he wanted to know it's reason. What is the reason for an object falling on the ground? An object falls on the ground because of the gravity.

CHAPTER - II
PROPOSITION

Proposition

Proposition is a logical entity and is defined as an assertion, contains Subject and predicate and a copula which either affirms or denies. Logical propositions are the atomic facts which picture the word in terms of assertions. A logical proposition explains the Atomic world. The relation between the proposition and the reality is like the Aristotle's Matter and form. Ludwig Wittgenstein States in his treatise Tractatus Logico Philosophicus that Language is the Symbolic representation of facts experienced, the facts like Objects, World, Nature, are represented in Symbolic form by Language. Propositions are the assertions which analysis Language. Propositions are further analyzed into elementary terms like Subject, predicate and Copula. Every elementary proposition Wittgenstein holds, is a picture of reality or the picture of some Atomic facts experienced. On the other hand, the world is composed of facts and can be completely analyzed into propositions. An Atomic fact(World) is a combination of objects. the proposition "this book is blue" can be true only if a book is expressed as blue. Logical analysis of the world of experience as pictured by propositions asserting the existence of the world composite of facts (or objects related) as the ultimate constituents of the world.

A proposition is an assertion in which something is said of something. Proposition has a value in philosophy just like as time has an importance in history and numbers in mathematics. Proposition is factual, assertive, having truth values, containing subject, predicate and Copula. Proposition mirrors the world and explains how world is ordered in its symmetry. It scans the world and the world is composed of atomic facts which are experienced and analyzed into propositions. The propositions of the world can be proved to be true or false. It will be illustrated with example like "this table is hard" can be true only if we experience the table by touch and it occupies space and its contradiction is false. If a proposition "this mobile phone is black" is true only when we perceive the quality of mobile phone as black and must be perceived, its shape like mobile phone, its functions and its contains Simcard. Proposition is objective and public and pictures the world, shows the relation between the world and the thought. Only those sentences are propositions which grammar regards as assertive. Propositions are always either true or false. So, world is an atomic fact i.e made of different realities like external objects, Universals, particulars, existence etc. Thus the purpose of proposition is the clarification of the concepts.

Meaning of Proposition

A proposition asserts that something is (or is not) the case. Any proposition may be affirmed or denied. The truth (a falsity) of some propositions for example, the proposition there is a life on some other planet in our galaxy- may not be known. So this is a proposition but it's truth value is not known objectively. Proposition thus differ from question which can be asked) and from commands (which can be given) and from exclamation, (which can be uttered) none of these can be asserted or denied truth & falsity apply always to propositions, but do not apply to questions, or commands, or exclamations. In Logic the word "statement" is sometimes used instead of proposition. For example, "India won the 1983 cricket world cup'' and "the 1983cricket world cup was won by India" are plainly two different sentences. That makes the same assertion.

1. It is raining (English)
2. Barsaat ho rahi hai (Hindi)
3. Mazha peeyyunnu (Malayalam)
4. Bishti porchhe (Bengali)
5. Roudhhh che pewannnn (Kashmiri)

These above propositions are in different languages, but they have a similar reference. These are called singular propositions having only one subject and predicate. There are singular propositions and compound proposition while the former is defined as the proposition having only one subject & predicate and the latter is defined as a proposition having more than one or two Subjects and predicates. There is also disjunction or alternative propositions a type of compound proposition which is in the form of "either...or". The hypothetical or conditional

Proposition is a type of compound proposition having conditional attitude.

Propositional Function

A propositional function is an expression containing one or more undetermined constituents x, y, and such that, if we settle what these are to be, the result is a proposition. Thus x is a man is a proposition function, because if you decide on a value for x, the result is a proposition- a true proposition if you define that x is to be Socrates or Plato, a false proposition if x is to be Cerberus a Pegasus. The values for which it is true constitute the class of man. Every propositional function determines a class namely the class of values of the variables for which it is true.[10]

Proposition and sentence

Proposition and sentence are two separate entities indicating their specific purposes, definitions and problems. A proposition is a logical entity. A proposition asserts that something is or not the case, any proposition may be affirmed or denied, all proportions are either true (1's) or false (0's). All propositions are sentences but all sentences are not propositions. Propositions are factual contains three terms: subject, predicate and copula and are always in indicative or declarative mood. While sentence is a grammatical entity, a unit of language that expresses a complete thought. A sentence may express a proposition, but is distinct from the proposition it may be used to express: categories, declarative sentences, exclamatory, imperative and interrogative sentences. Not all sentences are propositions. Sentence is a proposition only in condition when it bears truth values i.e. true or false. We use English sentences governed by imprecise rule to state the precise rules of proposition. In logic we use sentence as logical entity having propositional function but grammatical sentences are different from logical sentences while the former are having only two divisions namely subject and predicate and may express wishes, orders, surprise or facts and also have multiple subjects and predicates and the latter must be in a propositional form which states quantity of the subject and the quality of the proposition and multiple subjects and multiple predicate make the proposition multiple.

Propositions are the material of our reasoning. Proposition is the logical unit of philosophy or we can say thinking. Propositions are sentences but only some sentences are able to take the position of proposition. The best quality for proposition is that it is either true (1, s) or false (0, s). A sentence is group of words which gives a complete sense or meaning. There are different type of sentences viz, exclamatory, negative, interrogative, optative, imperative but in order to become proposition sentence must satisfy same conditions which are necessary for proposition i.e. sentence must contain three terms (subject, predicate, and copula) having truth values (true/false), must be in a declarative or assertive mood and must be a fact. A sentence is a grammatical entity belongs to a specific language. The question: how old are you? Who is your father? Are you a student? Which colour you like most? commands: go there, get out, shut up, take whatever available and exclamation: what a beautiful girl! What a book! Oh my God! How charming are you! are sentences. Such sentences don't have any truth values as they don't assert or deny anything. Proposition thus are different from questions (which can be asked) and from commands (which can be given) and from exclamation (which can be uttered) none of these can be asserted or denied. Truth or falsity apply always to propositions but do not apply to questions, commands and exclamation. In logic, the word 'statement' is sometimes used instead of proposition which was advocated by the modern philosopher P.F. Straw son.

Judgment and proposition

Judgment refers to the process of thinking. Thinking involves judgment; therefore, judgment is a mental process. We think or judge though ideas and when these ideas constituting judgment are expressed in language, it is called proposition. Logic is the science of ideas; we form ideas by the mental process of judgment. When this judgment is expressed in words it became a proposition of example, when I see a rose and I judge it to be red. The whole process is going in my mind, but the moment I say "this rose is red" make an assertion. This assertion is a proposition and let us considers certain facts of psychology of perception. And when I see a rose and judge it to be red I may also judge that rose in the garden and that it must be sweet smelling etc. but what I assert is implied to the fact that the colour of the rose is red my judgment is neither true nor false. Where as a proposition is either true or false, because judgment is subjective and private while proposition is a meaningful assertion and is comprised of two terms subject and predicate related by a copula neither rose nor red are meaningful in themselves, only when the two are related do we have a meaningful idea. Accordingly, proposition is the basic unit of thinking.

A proposition is an assertion in which something is said of something; therefore, every proposition has two has two elements which are related in a particular way. The elements of a proposition are called terms and the word relating them is called copula. In the proposition “Aristotle was a wise man’’ Aristotle is the subject term “a wise man” the predicate term and “is” a copula.

- **Subject:** that about which something is said is the subject of a proposition.
- **Predicate:** what is said of the subject is the predicate.
- **Copula:** the copula of proposition is invisibly same form of verb “to be” i.e., “is” “are” etc. the copula may be positive or negative, that is it may show that, subject has certain attributes or may show it does not have them. However, the copula does not indicate whether the subject is existential or non- existential.2

Sentence: A grammatical unit

Sentence is the smallest unit of communication. The smallest entity whose production constitutes a message given such factors as variations of phonetics or spelling, recognition of two speech acts as the production of the same sentence is already a matter of interpretation, but one that is usually automatic to speakers of the same native language. Grammatically a sentence is the unit whose structure is sub served by other recognized features of a language. The priority of the sentence in much analytic philosophy is summed up in “Frege's dictum that that is it is only in the context of a sentence that words have meaning”. The least controversial interpretation of the slogan is that for a word to mean anything is simply for it to contribute systematically to the meaning of whole sentences in which it is embedded. A word is not a thing with its own projection into parts of the world; instead, the presence of a word (or more accurately, a Morpheme) is a feature of a sentence. A more radical extension of the same line suggests that it is only in the context of a whole theory, or world view, or language that a single sentence means anything. In the terminology of Dummett, priority to words is semantic 'atomism' to sentences; 'molecularism' and to anything larger ' holism'.4

Sentence: A logical Unit

Aristotle maintained that a single proposition was always either the affirmation or the denial of a single predicate of a single subject: 'Socrates is sitting ‘affirms’ sitting of Socrates. ‘Plato is not flying’ denies ‘flying’ of Plato. In addition to simple predications such as those illustrated here, with individuals as subjects, he also regarded sentences with general subjects as predications: ‘All Greeks are humans; ‘dogs are mammals; ‘cats are not bipeds’ (Here he separate from modern logic, which since Frege has seen such sentences as having a radically different structure from predications). Aristotle's logical theory is in effect the theory of general predications. In addition to the distinction between affirmation and denial, general predications can also be divided according as the predicates is affirmed or denied of all (universal) or only part (particular) of its subject. There are then four types of general predications.

Affirmed (affirmative). Denial (negative)

Universal Every human is mortal. No human is mortal.

Particular "Some humans are mortal” "Not every human is mortal".5

Despite their diversity, natural languages have many fundamental features in common. From the perspective of universal grammar (see e.g. Chomsky 1986), such languages as English, Navajo, Japanese, Swahili, and Turkish are far more similar to one another than they are to the formal languages of logic. Most obviously, natural language expression fall into lexical categories (parts of speech) that do not correspond to the categories of logical notation, and some of them have affixes, including prefixes, suffixes, and markings for tense, aspect, number, gender, and case moreover, logical formalisms have features that language lack. Such as the overt presence of variables and the use of parenthesis to set off constituents. The conditions on well-formed formulas in logic. (wff)4are far simpler than those a well formed (Grammatical) sentences of natural language, and the rules for interpreting (wff) are far simpler than those for interpreting grammatical sentences compare any book on syntax and any book on formal logic and you will find many further differences between natural languages to documents those differences in detail fortunately, we will be able to discuss particular examples and some general issues without assuming any particular syntactic framework. We will focus mainly on logically significant expressions (in English) such as 'and', 'or', 'if', 'some' and 'all' and consider to what extent their semantics is captured by the logical behavior of their formal counterparts, 'and', 'or', 'v', ⊃, '≡', there exists, for all, rendering ' if ' as the material conditional ' horse shoe ' is notoriously problematic, but, as well shell see, there are problems with the others as well in many cases, however, the problems are more apparent than real. To see this, we will need to take into account the fact that there is a pragmatic dimension to natural language.

Relation between Sentence and proposition

As we know that proposition is a logical unit and sentence is a grammatical unit. Propositions are stated using sentences. However, all sentences are not propositions for example the sentences:

a) Snakes are poisonous

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[4]In mathematical logic, a well-formed formula, shortly wff, often simply formula, is a word (i.e. a finite sequence of symbols from a given alphabet) that is part of formal language.

b) Some students are hard workers are the two statements that are assertions and we can say of these statements that they may be either be true or false. Therefore, they are propositions.

Let us consider some sentence which is not propositions I.e.

a) How old are you.

b) May God bless you.

c) What a car.

d) Vote for me.

May God bless you, is a ceremonial statement and it is neither true nor false. Therefore, such statements are not propositions.

'What a car' is exclamatory and has nothing to do with being true or false. Exclamatory sentences are not propositions. 'Vote for me' is an appeal or command. We cannot attribute truth or falsity to it. Therefore, evocative statements are not propositions.

However, we can't say whether or not the question "How old are you"? is true or false. The essence to the question 'I am 16 years old' may be true or false. The question is not a proposition, while the answer is a proposition.

Sentential logic in Aristotle and Afterwards

Aristotle never developed an account of Sentential logic (the inferences that rest on Sentential operators such as ('and' 'or' 'if' 'not'). In my opinion, this is closely connected with his use of his logical theory in the posterior Analytics. His argument that 'every regress terminates' can only work if the logic of arguments 'in the figures' is the only logic there is; and for that to be so, every proposition must either affirm or deny a predicate of a subject, in fact, Aristotle thinks that this is so, and he undertakes to show it in the prior Analytics. This requires him to reject Sentential composition. He does not recognize conjunction, disjunction, or conditional as individual proposition. Precisely how this is to work is not clear, though we can discern a few details. For instance, because he treats affirmations and denials as two basic types of sentences, he does not think of negations as compound sentences, he appears to regard conjunctions not as single compound sentences but only as, in effect, collections of sentences (I.e. their conjuncts), and he treats conditionals not as assertions but as agreements to the effect that one sentence (the Antecedent of the conditionals) entails another (the consequent). Subsequent logicians, including Aristotle's own close associative Theophrastus, did not follow him in this and instead offered analysis of the role of Sentential composition in arguments with Chrysippus, this develops into a full - fledged Sentential logic, resting on five, Indemonstrable, forms of inference. The Stoics stated that these using ordinal numbers as place - holders for propositions:

1. If the first, then the second, the first; therefore, the second.
2. If the first, then the second, not the first; therefore, not the second.
3. Not both the first & the second; the first; therefore, not the second.
4. Either the first or the second; the first; therefore, the not the second.
5. Either the first or the second; not the first; therefore, the second.

CHAPTER-3
DEDUCTIVE LOGIC

Deductive logic

Deductive reasoning is distinguished from inductive reasoning by the intended support that the premises provide the conclusion. Deductive arguments present a context of reasoning within which the premises are intended to offer certain and absolute support for the truth of the conclusion. I emphasize "intended" because there are two ways in which a deductive argument may fail its intention to present a true conclusion from a given set of premises. It may fail because the structure of the argument is flawed. Here, the relationships between the premises do not, in fact, provide sufficient support to ground the conclusion. Such an argument is considered to be logically invalid. In this context, invalid is a technical term, referring specifically to a structural flaw in the argument. It is also true that a deductive argument may have a flawless or valid structure, yet have one or more false premises. In either case, the argument is not a good one and is considered to be unsound. The standard demanded by deductive reasoning is high. We expect the conclusion to be fully and clearly justified by reference to its premises, to follow from those premises with absolute certainty. A deductive argument is making the claim that if the premises are true, the conclusion is necessarily, undeniably true. Several values support the high standard set for deductive reasoning. They include precision, explicitness, transparency, and clarity. Because ambiguity opens up questions of interpretation and further debate, we should avoid ambiguity at all costs. The strongest feature of a deductive argument is the formal relationship that exists between its premises. It is this relationship that determines whether or not the premises provide a solid ground to support the conclusion, and allow it to be drawn forward. In a deductive argument, the relationships between the premises, and not their content, determines whether or not an argument is valid, or structurally strong. We will consider different types of deductive argument structure to familiarize ourselves with some of these basic patterns. Syllogisms are one category of deductive arguments. A syllogism is a simple deductive argument structure that has exactly two premises and a single conclusion. Different types of syllogisms are distinguished by the type of statements contained in the premises. Each type of syllogism has a clear pattern that makes it easy to analyze and identify, although not all syllogisms are valid. Their patterns must be studied carefully to distinguish those that are valid from those that are fallacious or structurally flawed. One common type of syllogism is called a disjunctive syllogism. A disjunctive syllogism is structured around a disjunctive statement given as a premise. A disjunction is a statement that presents alternatives. In English we usually use the coordinating conjunction "or" to construct disjunctions. An example of a disjunction would be, "I will take Math or I will take Logic." Another example would be, "I will pay for medication or for food." From a disjunctive statement alone, we cannot validly draw a conclusion. But if we have a second statement that relates to the disjunction statement we may be able to derive a necessary conclusion.

Consider the following example: Premise 1: Either I will take Math or I will take Logic. Premise 2: I will not take Logic. Conclusion: I will take Math. This form of argument has a strong structure. We can recognize this form in many other arguments, or even in our own reasoning. We can abstract, or separate the content of the argument and bring the form of this type of syllogism into the foreground by focusing on logically significant language. Premise 1: Either A or B. Premise 2: Not A. Conclusion: B. Showing the structure of the argument in this way, lets us see the intended structure clearly. We use capital letters A and B to symbolize the statement content of the argument. The symbols we choose to represent the content are arbitrary. We can choose any symbols we like, as long as we consistently use a single symbol for each statement. We retain the words (either-or, not) that link the simple statements because it is this language that carries the logic of the argument. This method of using symbols to show structural relationships between statements in an argument is one technique logicians use to analyze arguments. Showing form in this way will let us recognize more easily when arguments share a common form. It also lets us see when the form of one argument differs from the form of other arguments. Consider the following example: Either the battery of my car is dead or else the regulator needs replacing. The battery is dead. So, I know the regulator does not need replacing. We can analyze the argument as follows. First, we separate premises from conclusion: Premise: Either the battery of my car is dead or else the regulator needs replacing. Premise: The battery is dead. Conclusion: The regulator does not need replacing Then, we use letters as statement symbols to show the argument's form: Premise 1: Either A or B. Premise 2: A. Conclusion: Not B. While these two arguments are similar, analyzing them and showing their form, shows clearly that they have different forms. We will learn techniques that will let us show how one of these forms is a valid form and the other is not.

Truth and Validity

Truth is quality of proposition in the sense that propositions are either true or false where as validity belongs to deductive arguments in the sense that arguments are either valid or invalid. The discussion concerning the nature of argument makes one arrive at the question of truth and validity in logic. Copi writes "truth and falsehood characterize propositions or statements and may also be said to characterize the declarative sentences in which they are formulated". Thus valid argument generally depends upon true statements. For example

All Horses are Mammals

All Mammals have Ears

Therefore, All Horses have Ears

Another example is

All Horses are Mammals

All Mammals have Wings (false proposition)

Therefore, All Horses have Wings (false conclusion)

Therefore, in that case the validity of an argument does not provide the guarantee about the truth of its conclusion

Truth is the attribute of a proposition that asserts what really is the case when I assert that Pacific Ocean is the deepest ocean of the world, I assert what really is the case, what is true. It means proposition picture the reality the reality as well as it pictures the truth and falsehood about the things of the world. If I assert that Mumbai ocean is the deepest ocean of the world, my assertion would not be in accord to the reality of the world, therefore, it would be false. Moreover, truth and falsity are concerned with statements and valid and invalid is concerned with arguments.

An argument may be valid even when its conclusion and one or more of its premise are false.

- Some valid arguments contain only true propositions i.e. true premises and a true conclusion

  All mammals have lungs

  All cows are mammals

  Therefore, all cows have lungs

- Some valid arguments contain only false propositions i.e. false premises and false conclusion

  All fruits are bitter

  All sweets are fruits

  Therefore, all sweets are bitter.

  This argument is valid because if its premises were true, its conclusion would have to be true also, but even though we know that both the premises and conclusion of this argument are false.

- Some invalid arguments contain only true propositions i.e. all their premises are true and their conclusion is also true

  If David will take balanced diet then he would be healthy

  David does not take balanced diet

  Therefore, David is not healthy.

- The true conclusion of this argument does not follow from its true premises.

- Some invalid arguments contain only true premises and false conclusion

If Salman Khan will take balanced diet, then he would be healthy

Salman khan does not take balanced diet

Therefore, Salman is not healthy

The premises of this argument are true, but its conclusion is false. Such an argument cannot be valid because it is impossible for the premises of a valid argument to be true and its conclusion to be false.

- Some valid arguments have false premises and a true conclusion

All birds are aquatic

All fishes are birds

Therefore, all fishes are aquatic

- The conclusion of this argument is true. As we know; moreover, it may be validly inferred from these two premises, both of which are widely false.

- Some invalid arguments have false premises and a true conclusion:

Some humans are aquatic

Some aquatic insects are humans

Therefore, some aquatic insects are aquatic

From the above example it is clear that this argument have false premises and true conclusion. Thus we can say that we cannot tell from the fact that an argument has false premises and a true conclusion whether it is valid or invalid.

It is clear from the above examples that there are valid arguments with false conclusion as well as invalid argument with true conclusion

Moreover, if a argument is valid and its premises are true, we may be certain that its conclusion is true also. To put it another way; if an argument is valid and its conclusion is false, not all of its premises can be true. When an argument is valid and all of its premises are true, we call it ‘sound argument’.

Syllogism

A syllogism is made up of two premises and one conclusion. In syllogism we are inferring a conclusion from two statements.

All Philosophers are Thinkers

All Rationalists are Philosophers

Therefore: All Rationalists are Thinkers

In above syllogism there are three statements and the first statement is called major premise, second is called minor premise and the third is called conclusion. Rationalists are known as Minor term, Thinkers is Major term and Philosophers is known as Middle term. Now the question is how we locate three terms; Minor term, Major term and Middle term. This is very easy task. First start from conclusion and represent Rationalists and thinkers by capital letters S and P then generalize this S and P in above two premises major and minor. The term which is absent in the conclusion is called middle term or we can say the term which is common in both the premises is known as Middle term denoted by capital M. Consequently, we will get the Form of the syllogism as

M----P

S-----M

S-----P

Major term: The predicate term of a conclusion is termed as Major term. It is denoted by capital P.

Minor term: The Subject term of a conclusion is termed as Minor term. It is denoted by capital S.

Middle term: The term which is common to both the premises is termed as Middle term. It is denoted by capital M.

Major premise: Major premise is the premise which contains major term. It is always located as first premise.

Minor premise: Minor premise is the premise which possesses minor term. It is always present in the premise as second place.

Some Chillies are Sweet

Some Vegetables are Chillies

Therefore: Some Vegetables are Sweet

No Cats are Bats

Some Flying Bats are not Cats

Therefore: Some Cats are not Flying

Kinds of Syllogism

There are three kinds of syllogism; Categorical syllogism, Disjunctive Syllogism and Hypothetical Syllogism. Categorical Syllogism: A deductive argument which contains three terms; Middle term, Major term and Minor term and three premises Major premise, Minor premise and Conclusion. Moreover, the syllogism must be in a standard form having categorical propositions its constituents.

All Crows are Black

Some Birds are not Crows

Therefore, Some Birds are Black

Disjunctive Syllogism: It a type of syllogism in which there are three propositions, while first premise is a compound disjunctive proposition, second premise negates one of the disjuncts and the conclusion affirms its another disjunct.

Either Plato is a Rationalist or an Idealist

Plato is not a Rationalist

Therefore, Plato is an Idealist.

Hypothetical Syllogism: it is a type of syllogism in which premises contains hypothetical propositions (conditional) which contains ‘if…. then’ where ‘if’ is called antecedent and ‘then’ is called consequent. Hypothetical syllogism is of two kinds; Pure hypothetical and mixed hypothetical where in pure hypothetical proposition, all premises are made up of compound conditional statements and in this syllogism conclusion affirms the antecedent of first premise and consequent of second premise and in mixed syllogism first premise is compound conditional statement, second premise is a categorical and as well as conclusion.

If X is true then Y is true

If Y is true then Z is true

If X is true then Z is true

Figure of the Syllogism

Every syllogism has its logical form. The form of a standard categorical syllogism is the denotation of the letters S, P, M. It is determined by the position of the Middle term in the premises. Hence if we change the middle term in the two premises there will be four possible combinations which consequently makeup four figures.

Figure - 1 **M----P**

S----M

:. S----P

All Poets are Philosophers

All Thinkers are Poets

Therefore All Thinkers are Philosophers

In First figure the Middle term is the Subject term in Major premise and Predicate term in Minor premise

Figure - 2

P----M

S-----M

:. S-----P

All Poets are Philosophers

All Thinkers are Philosophers

Therefore All Thinkers are Poets

In second figure the Middle term is the Predicate term in both the premises

Figure 3

M------P

M-----S

:. S------P

Some Philosophers are Idealists

Some Philosophers are Realists

Therefore, Some Realists are not Idealists

In third figure the middle term is the Subject term in both the premises

Figure 4

P-----M

M-----S

:. S-------P

All Stones are Hard

Some Hard substances are colored

Therefore, Some Colored things are Stones

In fourth figure the Middle term is the Predicate term in Major premise and Subject term in Minor premise.

Mood

The Mood of the syllogism is determined by the four categorical propositions A, E, I, O and their respective qualities and quantities. The three letters must be present in standard form of Major Premise-Minor premise and Conclusion which further constitutes the mood of the syllogism. Every syllogism has its mood. For example

AEE, AIO, AII, OII, AEA and so on are known as mood of the syllogism.

A-All Poets are Philosophers__ Major Premise

A-All Thinkers are Poets___ Minor Premise

A-Therefore All Thinkers are Philosophers __Conclusion

The Mood of the above syllogism is AAA

I-Some Philosophers are Idealists __Major Premise

I-Some Philosophers are Realists __Minor Premise

O-Therefore Some Realists are not Idealists __Conclusion

The Mood of the above syllogism is IIO

A-All Stones are Hard __ Major Premise

I-Some Hard substances are colored __ Minor Premise

I-Therefore Some Colored things are Stones __Conclusion

The Mood of the above syllogism is AII

Moreover, we have four propositions which constitutes 16 Moods without conclusion

AA EA IA OA

AE EE IE OE

AI EI II OI

AO EO IO OO

Similarly, the four propositions A E I O constitute 64 moods and with the help of four figures, the number of moods of the syllogism is 64x4= 256

Moods of Four Propositions A E I O + Moods of Four Figures = 256 Moods

Which implies that out of 256 moods only some moods are valid and others are invalid and the valid moods possesses their technical names like AAA is called Barbara.

Chart of valid Moods

Valid moods of figure first

AAA -1 BaRBaRa

EAE-1 CeLaReNT

AII- 1 DaRii

EIO – 1 FeRio

Valid Moods of Figure Second

AEE -2 CaMeSTReS

EAE -2 CeSaREe

AOO- 2 BaRoKo

EIO -2 FeSTiNo

Valid Moods of figure third

AEE-3 DaTiSi

IAI-3 DiSaMiS

EIO-3 FeRiSoN

OAO-3 BoKaRDo

Valid Moods of fourth figure

AEE-4 CaMeNeS

IAI-4 DiMaRiS

EIO-4 FReSiSoN

Rules of Validity of Syllogism

Rule-1 Every syllogism must have three terms.

A syllogism must have tree and only three terms, no less no more. If there are two terms only inference can be "immediate" and not immediate. If there are four, the fallacy of four terms occurs. An argument like Ram is my friend, Mohan is rams friend, there Mohan is my friend, is invalid because it has four terms Viz, ram, Mohan, my friend and Mohan's friend, secondly there should be no ambiguous use of terms, that is, the meaning of the term should not change within the arguments. violation of this rule leads to three kinds of fallacy.

a) Ambiguous Major

Brave do not run

Ram is brave

Ram does not run

Obviously, the meaning of "run" in the major promise is not same as in the conclusion.

b) Ambiguous Minor

Vice is to be condemned

Ram is working with vice

Ram is to be condemned

'vice' in minor means a tool and not evil in the major

c) Ambiguous middle

Blue is a colour

Sky is blue

Sky is a colour.

Rule 2

The middle term must be disturbed in at least one premise. Moreover, at least one of the premises should distribute the middle term otherwise fallacy of undistributed middle occurs

Example

All insects are poisonous

All bees are poisonous

Therefore, All bees are insects

Here the Middle term "poisonous" which is predicate in both the premises is undistributed. It must be distributed in one of the premise but it does not.

Rule 3

A term which is distributed in the conclusion must be distributed in the premises. Here according to this rule, two fallacies occur one is fallacy of illicit major and fallacy of illicit minor. Hence this process is known as illicit process.

Illicit major

Some politicians are intelligent

No intelligent persons are president

:. Some presidents are not politicians

Here the term politician, does not distributes in the major premise but distribute in the conclusion and this violation leads to fallacy of major term.

All cows are Mammals

No Horses are Cows

Therefore, No Horses are Mammals

Here major term mammals gets distributed in the conclusion but remains undistributed in the major premise. Hence it violates the rule that if a major term is distributed in the conclusion then it must be distributed in the premises

Illicit minor

All idealists are Philosophers

All idealists are thinkers

Therefore, all thinkers are philosophers

In the above argument conclusion is true but it is logically invalid. Here the term 'thinkers' is distributed in the conclusion but it remains undistributed in the premises.

Another example is

No Indians are ungrateful

All Indians are religious

Therefore, No religious person is ungrateful

This is apparently false because while it is given that 'no Indians are ungrateful', this does not guarantee that no non-Indians are ungrateful but the class of religious persons includes Indians as well as non-Indians. This argument commits fallacy of illicit minor because the minor term religious person is distributed in conclusion while it does not distribute in the premises.

Rule 4: From two negative premises no conclusion can be drawn

A formal mistake in which both the premises of a syllogism are negative and we cannot infer conclusion. If both the premises are negative, no conclusion follows. In case both the premises are denials of certain attributes to subject term, no connection is established between major and minor terms through middle term. For example, if one says, A is not B and B is not C, we cannot know where A is C or is not C, because if for e.g. Ram and Shyam are not stupid, from this we cannot infer anything other than what is already asserted in proposition. The fallacy which occurs due to violating this rule is known as fallacy of exclusive premises.

Example

No angels are mortal

No crows are mortal

Therefore, No crows are angels

Rule 5: If one premise is negative then the conclusion must be negative

According to this rule, if one of the two premises is negative then the conclusion must be negative. However, if one premise is negative and the conclusion is affirmative then fallacy occurs and this fallacy is known as **fallacy of drawing an affirmative conclusion from negative premises.** It is formal mistake in which one premise of a syllogism is negative but the conclusion is affirmative. I will give an example in which there is no fallacy.

If A is B

B is not C

Therefore, A is not C.

Example of Fallacy of drawing an affirmative conclusion from negative premises

No sculptors are lawyers

Some artists are sculptors

Therefore, some artists are lawyers

Rule 6: If one premise be particular then the conclusion must be particular

It is a syllogistic fallacy in which a mistake occurs when we are inferring a particular conclusion from two universal premises. To break this rule is to go from premises having no existential import to a conclusion that does. A particular proposition asserts the existence of objects of a specified kind, so to infer it from two universal premises that do not assert the existence of anything at all is clearly to go beyond what is warranted by the premises. Thus for any syllogism that violate rule 6 may be said to commit the fallacy known as Existential fallacy. For example

All humans are mortal

No angels are mortal

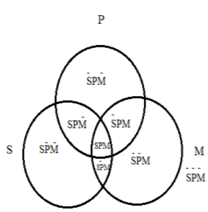
Therefore, some angels are not humans

This syllogism is invalid because its premises do not assert the existence of angels and its conclusion is also false. Thus these universal propositions are without existential import. So in this a fallacy could arise and that fallacy is known as existential fallacy. Hence we cannot infer a particular conclusion from universal premise as they are without existential import.

Venn diagram technique for testing syllogism

In order to test a categorical syllogism by the method of Venn diagram, one must first represent both of its premises in one diagram. Venn diagram requires drawing three overlapping circles for the two premises of a standard form syllogism which contains three different terms; minor term, major and middle term. These three terms are abbreviated as S, P and M respectively. Moreover, we draw two circles and a third circle beneath. These three circles are overlapping each other. Then we have S and $\overline{S}$, P and $\overline{P}$, M and $\overline{M}$.

Now S determines the class of all Kashmiries, P determines the class of all Villagers and M determines the class of all Apple growers. SPM is the product of these three classes, $SP\overline{M}$ is the product of the first two and the compliment of the third that is the class of all Kashmiri villagers who are not apple growers. $S\overline{P}M$ is the product of the first and third class and the compliment of the second, that is the class of all Kashmiri apple growers who are not villagers. $S\overline{P}\overline{M}$ is the product of first and the compliment of villagers and apple growers that is the class of Kashmiries who are neither villagers nor apple growers. $\overline{S}PM$ is the product of second and third classes with the compliment of the firs; the class of villagers who are apple growers and who are not Kashmiries. $\overline{S}P\overline{M}$ is the product of the second class with the compliment of the other two; the class of villagers who are neither Kashmiries nor apple growers. $\overline{S}\overline{P}M$ is the product of the apple growers and the compliment of Kashmiries and villagers; the class of all apple growers who are neither Kashmiries nor villagers and finally $\overline{S}\overline{P}\overline{M}$ is the product of the compliment of first, second and third i.e. the three original class; the class of all things that neither Kashmiries nor villagers as well as nor apple growers.



If we focus our attention on just the two circles labeled a P and M, it is clear that by shading out or by inserting an x, we can draw out any standard form categorical proposition whose two terms are P and M, which is subject and predicate. Thus, to diagram the proposition ‘all M is P’ ($M\bar{P}=0$), we shade out all of M that is not contained in (or overlapping by p). Including both the portions labeled $S\bar{P}M$ and $S\bar{P}M$, the diagram then becomes different from the original one.

X is always placed on the line of the circle designating the class mentioned in that premise.

And if we focus our attention on just the two circles S and M, by shading out, or by inserting an x, to diagram the proposition ‘all S is M’ ($S\bar{M}=0$) we shade out all of S that is not contained in M. This area includes both the portions labeled as $S\bar{P}\bar{M}$ and $SP\bar{M}$. The diagram for this proposition will appear different from the original one.

Thus the diagramming both ‘all M is P’ and ‘all S is M’ at the time give us shaded figure.[5]

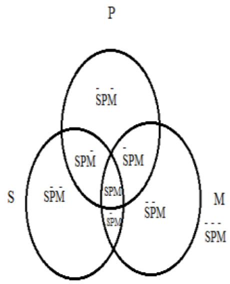
This is the diagram for both premises of the syllogism AAA-I

Let’s now apply the Venn diagram test to an obviously invalid syllogism, one contradicting three A propositions in the second figure.

Diagramming both premises gives us valid diagram, where S designates the class of all cats, P designates class of all dogs, and M designates class of all mammals; the portions $S\bar{P}\bar{M}$, $SP\bar{M}$ and $\bar{S}P\bar{M}$, have been shaded out, but the conclusion has not be diagrammed because the part $S\bar{P}M$ has been left without shade, and to diagram the conclusion both $S\bar{P}\bar{M}$ and $S\bar{P}M$ must be shaded. Thus we see that diagramming both the premises of a syllogism of form AAA-2 does not suffice to diagram its conclusion which proves that the conclusion says something more than is said by the premises, which shows that the premises do not imply the conclusion. Since an argument whose premises do not imply its conclusion is invalid, and so our diagram proves

[5] I have not shaded Venn diagrams, so I put this task for learners to shade diagrams for different syllogisms.

the given syllogism to be invalid (:. AAA-2 is invalid).



When we use a Venn diagram to test a syllogism with one universal premise and one particular premise, it is important to diagram the universal premise first, thus in testing the AII-3 syllogism i.e.

All Poets are Artists

Some Poets are Writers

Therefore, Some Writers are Artists

We examine it to see whether the conclusion already has been diagrammed. If the conclusion ‘Some writers are artists’ has been diagrammed, there will be an x somewhere in the overlapping part of the circles labeled as “writers and artists”, this overlapping part consists of both of the regions SP$\overline{M}$ and SPM, which together constitute SP. There is an x in the region SPM, so there is an x in the overlapping part SP. Thus what the conclusion of the syllogism says has already been diagrammed by the diagramming of its premises, therefore the syllogism is valid.

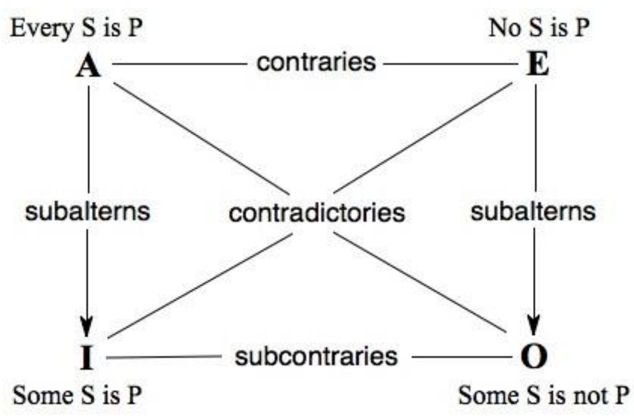
All great empiricists are masters

Some scientists are masters

Therefore, Some scientists are great empiricists.

Square of Opposition of Propositions

Square of opposition indicates the relation between the four propositions A, E, I and O, This relation is opposite which consists of four oppositions i.e. contradiction, contrary, sub-contrary, and sub- alternation.



Contradiction: Two propositions are said to be in a contradictory relation when they have same subject and predicate but they differ in both quantity and well as quality. Contradiction exists between the propositions A and O and between E and I. e.g.

All Logicians are Philosophers

O- Some Logicians are not Philosophers

And between

E-No Logicians are Philosophers

I- Some Logicians are Philosophers

All S is P (U.→N)

O- Some S is not P

In contradiction two propositions cannot both be true or false i.e.

If A is true, O is false, and if O is true, A is false

If E is true, I is false, and if I is true, E is false.

Contrary: Two propositions are said to be contrary when they have same subject and predicate but they differ in quality. Contrary relation holds between the propositions A and E and its vice versa. E.g.

All Logicians are Philosophers

E- No Logicians are Philosophers.

Now according to contrary relation, two propositions cannot both be true if one is true, other must be false, but both may be false or doubtful, i.e.

If A is true, E is false, and if E is true, A is false

If A is false, E is doubtful, and if E is false, A is doubtful.

Sub- Contrary: Two propositions are said to be sub-contrary when they have same subject and predicate but they differ in quality. Sub-contrary relation exists between the propositions I and O and it's vice versa, e.g.

Some politicians are Cowards

O- Some politicians are not Cowards

Now according to sub-contrary relation, two propositions cannot both be false if one of them is false other must be true, but both may be true or doubtful. i.e.

If I is false, O is true, and if O is false, I is true.

If I is true, O is doubtful, and if O is true, I is doubtful.

Sub-Alteration: Sub-Alteration relation holds between the propositions A and I, and between E and O. Two propositions are said be sub-contrary when they have same subject and predicate but they differ in quantity. E.g.

All vegetables are fruits.

Some vegetables are fruits

And between

E- No vegetables are fruits.

O- Some vegetables are not fruits.

Now according to sub-contrary relation, A and E are super-altern and E and O are sub altern. Thus from the truth of universal proposition we can infer the truth of its particular proposition but not its vice versa and from the falsity of particular propositions we can infer the falsity of its universal propositions but not its vice versa. i.e. God can send truth downwards and Devil can send falsehood to upwards. In sub-alteration relation, A implies or subsumes I, and E implies or subsumes O.

If A is true, I is true, and if I is true, A is doubtful.

If I is false, A is false, and if A is false, I is doubtful.

Similarly, if E is true, O is true, and if O is true, E is doubtful.

If O is false, E is false, and if E is false, O is doubtful.

Inference

Inference is the cognitive process of deriving a conclusion from more than one proposition. When inference is expressed in language it is called argument.

Immediate inference: In this conclusion is derived from single premise as when we say “All teachers are educated” we can easily make its immediate inference “Some teachers are educated”

Further immediate inferences are Conversion, Obversion, and Contraposition.

Conversion

An inference formed by interchanging the subject and predicate terms of a categorical proposition. Not all conversions are valid. There are three cases for conversion

In conversion the subject of the original becomes the predicate of converse and the predicate of the original becomes its subject.

The quality of the original must not change. If the premise is affirmative, the conclusion must be affirmative. If the premise is negative, the conclusion must be negative.

What is distributed in the premise, must be distributed in the conclusion. It can be stated in another way. A term can be distributed in the conclusion only if it is distributed in the premise. However, a term, which is distributed in the premise, may or may not be distributed in the conclusion. E.g.

All S is P (All crows are Black) = convertend

In this above A type proposition conversion is not possible directly because ‘all S is P’ cannot be converted into All P is S, the problem is that subject term distributes but predicate term remains undistributed. We can say all crows are black, but not all black things are crows. So the conversion of ‘All S is P’ is ‘Some P is S’ by limitation only because the quantity is reduced from universal to particular.

The immediate inference (converse) of E-type proposition ‘No men are angel’ is ‘No angels are men’.

The immediate inference (converse) of I-type proposition ‘Some men are wise’ is ‘Some wise persons are men’

The immediate inference (converse) of O-type proposition ‘Some men are not farmers’ is not valid as in this case the fallacy of conversion occurs. This fallacy also occurs when All S is P is converted into All P is S. Consider the propositions

All Africans are black.

:. All black persons are Africans

Some gods are not powerful

:. Some powerful beings are not gods

In both the above examples the conversion is not valid because the terms ‘black’ and ‘gods’ are distributed in the conclusion while they are undistributed in the premises.

Obversion

An inference formed by applying two rules for obversion

Change the quality of the proposition without any change in its quantity.

Replace the predicate term by its complement or contradictory.

Conversion is valid for all the four propositions (A, E, I, O). So we apply these two laws to the premises (A, E, I, O) to obtain conclusion. The conclusion is called obversion. In obversion, universal affirmative changes into universal negative and its vice versa and particular affirmative into particular negative and its vice versa

A - All Indians are Vegetarians → E- Therefore, No Indians are non-vegetarians.

E - No gods are humans → A- Therefore all gods are non-humans

Some girls are beautiful →O- Therefore, some girls are not non-beautiful.

O - Some girls are not ugly → I-Therefore, some girls are non-ugly.

Contraposition

An inference formed by replacing the subject term of a proposition with the complement of its predicate term, and replacing the predicate term by the complement/ contradictory of its subject term. All contrapositions are not valid. In contraposition neither the quality nor quantity of the original proposition is changed and only the quality of a propositions are contraposed.

For e.g. the contrapositive of the A-type proposition “All Whales are Fishes” is “All non-Fishes are non-Whales”.

Contraposition is a double process i.e.

First step: Obversion

Second step: Conversion

Third step: Obversion

Suppose “All Indians are Asians” is a proposition and we want its contrapositive.

First stage: All S is P obverts to No S is non-P.

Second stage: Then its conversion is ‘No non-P is S’

Third stage: Then further its obversion is ‘All non-P is non-S.

So, the contrapositive of the proposition ‘No S is P’ is ‘Some non-p is not non-s.(by limitation).

The contrapositive of the proposition ‘some s is p’ is not valid. For e.g. the obversion of ‘Some S is P’ is ‘Some S is not non-P’ then its conversion is not valid, so its contrapositive is not valid.

The contrapositive of ‘Some S is not P’ is:

Obversion: Some S is non-P.

Conversion: Some non-p is S.

Obversion: Some non-P is not non-S.

Thus the contrapositive of the proposition ‘Some Scholastics are not Philosophers’ is ‘Some non-Philosophers are not non-Scholastics

Dilemma

The dilemma is a common form of an argument in ordinary language in which it is claimed that a choice must be made between two alternatives and the alternatives are usually bad. The dilemma is a double grip reasoning which puzzles a man. The Speaker in parliament of Indian used to ask the question to one of the minister of centre that ‘Have you stopped money laundering Mr. X?’ in this question Speaker make use of dilemma and both affirmative and negative answers implicate the witness. A dilemma combines conditional and disjunctive statements. The question of the Speaker actually is “Either Minister has stopped money laundering or has not stopped it”; and if he has stopped then he was involved in money laundering in past and if he has not stopped then he is still involved in money laundering. Therefore, the person who is not involved in money laundering cannot make any answer because his options are closed.

In dilemma, the premises of a syllogism are so combined and devised disjunctively that it creates a trap for the opponent by forcing him to accept one or other disjuncts (alternatives). Thus the opponent is restricted to accept the truth of the conclusion of one or the other of the syllogisms combined. When this is done successfully, the dilemma can prove to be a powerful instrument of persuasion. In dilemma, both the disjunctives or dilemmas are called ‘horns of dilemma’.

However, if the dilemma affirms the antecedent of the major, it is called constructive dilemma and if it denies the consequent it is called destructive dilemma.

In a simple dilemma, the conclusion is a single categorical proposition and in a complex dilemma, the conclusion itself is a disjunction. We can also describe it as, if the conclusion is the same whichever alternative is accepted, it is simple; and if the conclusion is different, then it is called complex dilemma.

The general form of constructive dilemma is

$(p \rightarrow q) \bullet (r \rightarrow s)$

$P \lor r$

$\therefore q \lor s$

The general form of destructive dilemma is

$(p \rightarrow q) \bullet (r \rightarrow s)$

$\sim q \lor \sim s$

$\therefore \sim p \lor \sim r$

Examples of different types of dilemma

Constructive dilemma

If we increase the price, sales will slump

$(p \rightarrow s)$

If we decrease the quality, sales will slump

$(q \rightarrow s)$

Either we increase the price or we decrease the quality

$(p \vee q)$

Therefore, sales will slump

Therefore, s

Destructive dilemma

If it rains, we will stay inside

If it is sunny, we will go for a walk

Either we will not stay inside or we will not go for a walk, or both

Therefore, either it will not rain, or it will not be sunny or both.

The argument form of above destructive dilemma is

$(r \rightarrow i)$

$(s \rightarrow w)$

$\sim i \vee \sim w$

Therefore, $\sim r \vee \sim s$

CHAPTER – IV
INDUCTIVE LOGIC

Inductive Logic

An inductive argument is an argument whose premise statements support the conclusion with some degree of probability. This is to say that if the premises are in fact true. Then the conclusion follows as more or less likely. The degree of likelihood follows from the extent and quality of evidence presented. For an inductive argument to be considered good or strong, the evidence offered in the premises needs to ensure a high likelihood that the conclusion will follow. The reasons presented in the premises should be sufficient (give enough evidence), relevant (be directly related to the subject matter of the conclusion), and true (factually verifiable). An inductive argument presents an open-ended context of inference. While the premises provide grounds for drawing a conclusion forward – and in a strong inductive argument that support will be able to assure the truth of the conclusion with a high degree of probability – even in a good inductive argument the structure of its reasoning will leave open the possibility that the conclusion could be false. For example, the fact that I have put the key into the ignition of my car many times, and I have been able to turn the engine over, provides me with good grounds to reason that putting the key into the ignition of my car this morning will turn the engine over. Indeed, I make this inference every time I put my key into the ignition and turn it, but I cannot conclude with absolute certainty that my car will start this time, and it may be that one day I do so and my car fails to start. The failure of my car to start, (the falsehood of my conclusion in this case), does not diminish the quality of my reasoning. This fact about inductive arguments should not lead us to conclude that inductive arguments are weak. As British philosopher and logician, Bertrand Russell pointed out, “All the important inferences outside logic and pure mathematics are inductive. The only exceptions are law and theology, each of which derives its first principles from an unquestionable text, viz. the statute books or the scriptures.” Law bases its arguments in stipulated rules and religion assumes universal truths. The limits provided by written law or religious beliefs, direct our reasoning within a specified scope. As long as that scope is assumed, conclusions can be drawn with the certainty required by deductive reasoning. Scientific reasoning, on the other hand, bases its arguments on tentatively presented hypotheses and works with evidence that is empirically verifiable (available to our sense perceptions). It adapts its conclusions to newly discovered evidence and therefore demands flexibility. As an example, consider how we predict the landfall of a hurricane. Many factors enter our reasoning as premises. These include facts about air pressure, the size of the storm, the temperature of the atmosphere and the water, the movement of various currents, the presence of landmasses. The list goes on. Different computer models offer different predictions, providing probable conclusions as to where and when the hurricane will make landfall. These models adjust or change their conclusions as they factor in new information, or premises. We base our conclusions regarding when and what areas to evacuate based upon these premises. Even if we have the most accurate information possible, the nature of the phenomenon about which we are reasoning is such that our predictions, our conclusions, may be wrong. This is not to denounce inductive reasoning as inferior. It is to recognize when and why probable knowledge is the best we can achieve. The quality of reasoning in an inductive argument is based on a scale of weak to strong. The factors we consider include the truth of the premises, their relevance to the conclusion, and the sufficiency of the evidence they provide to support the conclusion. We can improve the quality of the argument by adding more true and relevant premises, or by deleting irrelevant ones. But a feature of inductive reasoning is that we may end up with a false conclusion from a set of true, relevant and sufficient (as possible at the time) premises. Scientific method and logic

Hypothesis

A hypothesis is a proposed explanation for a phenomenon. For a hypothesis to be scientific hypothesis, the scientific method requires that one can test it. Scientists generally base scientific hypothesis on previous observations that cannot satisfactorily be explained with the available scientific theories. Even though the terms ‘hypothesis’ and ‘theory’ are often used synonymously, a scientific hypothesis is not the same as a scientific theory. A working hypothesis is a provisionally accepted hypothesis proposed for further research, in a process beginning with an educated guess or thought. A different meaning of the term hypothesis is used in symbolic logic, to denote the antecedent of a proposition. Thus in a proposition, if p then q, p denotes the hypothesis or antecedent and q can be called a consequent. The formulated hypothesis is then evaluated whether either the hypothesis is proven to be 'true' or 'false' through verification principle or falsification principle.

A hypothesis must be self-subsistent and the conclusions derivable from it deductively must not contradict. A hypothesis must not be vague, when its meaning is ambiguous, its truth cannot be verified. One more thing which is significant for hypothesis is that hypothesis must be verifiable, i.e. its consequences must be stated in terms of determinate empirical observations.

Mill has defined hypothesis as "any supposition which we make (either without actual evidence, or an evidence avowedly insufficient) in order to endeavor to deduce conclusions in accordance with the facts which are known to be real, under the idea that if the conclusions to which the hypothesis leads are known truths, the hypothesis either must be or at least likely to be true". According to Copi and Nagel, "A hypothesis directs our search for the order. It is not necessary for a hypothesis to be necessarily to be true. Hypothesis is a bridge in the process of inquiry or search which begins with some felt difficulty of problem and ends without the resolution of the problem.

Steps of hypothesis

The steps which hypothesis includes are; observation, reflection, logical reasoning (inductive and deductive) and verification

1. **Observation:** Observation is the primary source for formulating hypothesis. it is the precondition of formulating hypothesis. Unless we perceive a difficulty or problem and do not feel inner push for solving it, we do not reflect. Therefore, observation is the first stage of hypothesis making.

2. **Reflection:** Reflection is the process of understanding and we could reflect when we felt difficulty in problem which needs a solution, we consider the problems by perceiving the relevant facts. For example, we see a sea in high tide and also find clear moon above. Now we anticipate a relation which is based upon an experience, namely, whenever there is high tide, there is full moon and never otherwise as far as our experience goes. Similarly, when we see smoke in forests, we felt that there is fire in forests and this experience we have explored when we have seen fire with smoke. Having established a relation between two facts we now formulate an answer for why of this relation. This answer or solution is hypothesis.

3. **Induction:** Induction is the process of collecting particular instances or information for the formulation of hypothesis. When we observe that falling a stone from the top of the building falls fast to the ground and falling a thread or cotton from the same top of the building could fall slowly, then we apply this problem to formulate the hypothesis 'why hard things like stone, iron fall fast and soft things like thread, cotton, etc. falls slowly.

4. **Deduction:** The fourth step is deduction which is examination of hypothesis from various deductive laws and axioms and their mutual compatibilities and correspondence with already known facts. The role of deduction in hypothesis is very much important because when we formulate hypothesis we must check its relation with generalized norms and rules. For example, if we have a hypothesis that madness increases with increasing complexity of civilization, it will follow from this that there are more mad persons in New York today than in Delhi. Now this is in fact not true. Therefore, our hypothesis is defective because certain facts which follow from it are false. Thus deduction is extremely useful in rejecting ill formed hypothesis.

5. **Verification:** Actually verification is post-hypothesis-formulation and therefore is not a step in its formulation, but in as much as our interest in making hypothesis is not purely academic or theoretical, we wish to solve our difficulty; and this difficulty can be solved if we actually test our hypothesis.

Kinds of hypothesis

1. **Explanatory or descriptive hypothesis:** A hypothesis may be about the cause of a phenomenon or about the law of which it is an instance. A hypothesis about cause is explanatory whereas a hypothesis about law is descriptive.
2. **Tentative hypothesis:** When a phenomenon cannot be fully understood because of technical difficulties we formulate tentative hypothesis about it and see how far this is successful in explaining. Sometimes we simultaneously test two or more hypothesis.
3. **Representative fictions:** According to Bain "some hypothesis consists of assumptions as to the minute structure and operation of bodies. From the nature of the case, these assumptions can never be proved by direct means. Their only merit is their suitability to express the phenomenon. They are representative fictions". Einstein's formula E=mc2 is an instance of representative fiction.

   The hypothesis is based upon imaginative reasoning and it primarily involves thinking without the help of concrete instances. This is why hypothetical reasoning is abstract. A hypothesis which proves to be correct becomes a theory or law. The law of gravitation was a hypothesis in Newton's mind, but when it proved to be true, it becomes a law.

Scientific and unscientific explanation

Scientific explanation is defined is a theoretical account of some fact or event, always subject to revision, that shows relevance, compatibility with previously established hypothesis, predictive power and simplicity. Whereas unscientific explanation is different from scientific explanation, it is defined as an explanation that is being presented and accepted dogmatically, and taken as true without evidence. Logical inference includes both the scientific and unscientific explanation. However, it is when one requires an explanation for something, what is it that is required? An account of some kind is sought, some set of statements about the world, or some story, from which the thing to be explained can be logically inferred. We want an account that eliminates or at least reduces the problematic aspects of what was to be explained.

Explanation and inference may be thought of as the same process viewed in opposite directions. A logical inference advances from premises to a conclusion. The explanation of some fact advances from the fact to be explained to the premises from which that fact may be inferred. For example, if p then q, where p is the cause and q is the effect, we must explain both p and q, i.e. what is the reason that p causes q and why q results from p.

However, if an explanation is to be satisfactorily it must be relevant under all circumstances. That is, the factors we identify must be appropriately related to the event for which we seek an explanation. Suppose I arrive late to work, and then offers as the explanation of my lateness the fact that there is continuing political disorder in India. Even if true, that will be thought absurd no explanation at all, because the fact to be explained, my lateness, cannot be inferred from it. For an explanation to be good, it must be both relevant and true. Scientific explanations go beyond particular events; they seek to provide an understanding of all the events of some given kind.

The unscientific explanation is presented and accepted dogmatically; the account is regarded as being absolutely true and no capable of improvement. The opinions of Aristotle were accepted, for centuries, as the ultimate authority on matters of facts but some facts were accepted dogmatically. Every explanation is there put forward tentatively and provisionally, proposed scientific explanations are regarded as hypotheses, more or less probable in the light of available evidence.

The most fundamental difference between scientific and unscientific explanations lies in the basis for accepting or rejecting the view in question. There should be evidence for scientific explanation but it is not necessary for unscientific explanation. Even sometimes an unscientific explanation has some evidences. The unscientific theory that planets are inhabited by 'intelligences', that cause them to move in their observed orbits can claim, as evidence, the fact that the planets do move in those orbits. Science is empirical in holding that the test of truth relies on our experience and therefore the essence of a scientific explanation is that it has the quality of testability. Testability is the capacity of a scientific hypothesis to be confirmed or disconfirmed. Thus explanation should be empirically verifiable and such verifiability is the essence of scientific explanation

Evaluating scientific explanation

A scientific explanation uses observation and evaluation to explain something we see in world. Scientific explanations should match the evidence and be logical, or they should at least match as much of the evidence as possible. Scientific investigation broadly defined, includes numerous procedural and conceptual activities, such as asking questions, hypothesizing, designing experiments, making predictions, using apparatus, observing, measuring, precision, error, recording and interpreting data, evaluating evidences, performing statistical calculations, making inferences and formulating and revising theories and models.

Examples

1. Scientific explanations we see in the world like 'why do objects fall to the ground'? Well, there is a force called gravity that attracts every object in the universe to every other object.
2. Why is earth blue? It is all about light scattering. We receive white light from the sun, and that light fills the earth's atmosphere. Most of the light that passes overhead keeps going and doesn't reach our eyes at all. But some of it is scattered by the air molecules and

bounces into our eyes. Blue light scatters more than any other color, so the sky appears blue to us.

A scientific explanation is a theory. Good theories make good predictions or hypothesis. Bad theories make bad predictions or hypothesis. The theory or scientific explanation is used to make predictions and hypothesis. If the theory cannot be used to make predictions, then it is not truly a scientific explanation An experiment or set of observations are carried out and examined and analyzed to determine if the hypothesis derived from the theory of scientific explanation actually worked. A scientific theory or explanation must be tested using hypothesis derived from the theory. An experiment or set of observations are used to test the explanation. The results of the experiments or set of observations are used to evaluate the theory.

There are three criteria's from which we can judge the merit of scientific explanation

1. **Compatibility:** A compatibility is a criterion for evaluating scientific hypothesis; the totally of hypothesis accepted at any one time should be consistent with each other. Scientific explanation must be self-consistent. In scientific explanation the new hypothesis must be compatible with those already confirmed. For example, Kant's concept of time and space is compatible with Newton's concept of absolute space and time.

2. **Predictive or explanatory power:** It is a criterion for evaluating scientific hypothesis; the range of facts deducible from a testable hypothesis. Every scientific hypothesis must be testable, as we have seen, and it will be testable if some observable fact is deducible from it. When we confront two testable hypotheses, of which one has a greater range of facts deducible from it than the other, we say that one has greater predictive or explanatory power. The greater the predictive power of a hypothesis, the more it explains. If a hypothesis is inconsistent with some well-attested observation, that hypothesis has been falsified and must be rejected.

3. **Simplicity:** A criteria for evaluating scientific hypothesis; the 'naturalness' of a hypothesis, which can be tricky to determine. Simplicity seems to be a 'natural' criterion to invoke. In ordinary life also we are inclined to accept the simplest theory that fits all the facts. In a criminal trial two theories about a crime may be presented, and the case is likely to be decided in favor of the hypothesis that seems simpler. Thus simplicity is an important criteria, even sometimes a decisive one but it is difficult to formulate and not always easy to apply.

Mill's Methods

John Stuart Mill in his work 'A System of Logic' formulated five patterns of inductive inferences and these methods are also known as 'Canons of induction' or 'Methods of Inquiry'. Moreover, the five techniques of inductive inference called Mill's methods are mentioned as:

1. The method of agreement
2. The method of difference
3. The joint method of agreement and difference
4. The method of residues
5. The method of concomitant variation.

The Method of Agreement

Mills defined method of agreement as: "if two or more than two instances of a phenomenon under investigation have only one circumstances in common, the circumstance in which alone all the instances agree is the cause or effect of given phenomenon". According to this method if we wish to know the cause or effect of something we should examine several instances similar to one under investigation, and if they are found to have one common factor, then this common factor is the cause of the effect depending upon whether it is antecedent or consequent of the phenomenon. Antecedent factor is always the cause and the consequent factor the effect. For example, if we wish to know the cause of stomach disturbance, we have to examine a number of stomach pain patients and if we find that being taking the water in that area contains chemical Sulphur. Then sulpur is the only cause of stomach disturbance and pain. Mellone and Coffey have termed this method as a method of exclusive agreement in as much as the various examples of a phenomenon agree in one and only one respect.

The method of agreement is considered to e primarily a method for observation and not experiment, because the use of this method is made in those cases where the control of conditions is not feasible and therefore no experiment is possible. The advantages of this method are the same as the advantages of observation. The range of phenomenon in which this method can be applied is very wide and moreover, by the use of this method we can move from cause to effect or effect to cause. That is we discover the cause of a given phenomenon or can discover the effect of a certain phenomenon.

Schematically, the method of agreement may be represented as follows, where capital letters represent circumstances and small letters denote phenomenon:

P, Q, R, occur together with x, y, z

P, S, T, O occur together with x, m, v

Therefore, P is the cause (or effect) of x

Thus it is common tool of scientific enquiry that looks for the sole circumstance invariably associated with the particular effect in multiple instances, and suggests that circumstances as the cause of the effect.

Method of Difference

Mill has defined method of difference as “if an instance in which the phenomenon under investigation occurs and an instance in which it does not occur, have every circumstance in common say one, that one occurring only in the former, the circumstance in which alone the two instances differ, is the effect, or the cause, or an indispensable part of the cause, of the phenomenon.

The method of difference require two instances which resemble each other in every other aspect, but differ in the presence or absence of the phenomenon investigated. According to the rule of difference nothing can be the cause of a phenomenon if the phenomenon fails to occur when cause occurs. For example, if clouds are considered as the cause of rain, then every appearance of clouds in the sky should be followed by rain. This does not happen many a time, therefore, clouds cannot be considered to be the cause of rain. Few more examples would clear it.

- The bell rings if there is air in the room, but if there is vacuum in the room it does not. Therefore, air is the cause of ringing.
- A man dies of snake bite but he was perfectly healthy before, therefore, snake bite is the cause of death
- A cup of tea tastes bitter but on the addition of sugar, bitterness disappears, therefore, sugar is the cause of sweetness of tea.

Systematically, the method of difference may be represented as follows and in this representation, capital letters denote circumstances and small letters denote phenomenon:

P, Q, R, S occur together with w, x, y, z

Q, R, S occur together with x, y, z

Therefore, P is the cause, or effect, or an indispensable part of the cause of w.

Thus method of difference is a common tool of scientific enquiry that looks for the sole circumstance that varies between an instance in which an effect is not produced, and considers that circumstance the cause or part of the cause of the effect.

Characteristics of the method of difference

- Whereas we cannot be certain about the cause of a phenomenon by the use of agreement method, the difference method is a practical and effective means of establishing cause of a phenomenon.
- By this method hypothesis can be easily tested. If we are justified in believing that aspirin relieves headache, we need to give aspirin to one person and sugar pill to the

other. If one of them becomes restful and relaxed in 20 to 40 minutes, then aspirin relives headache.

Joint Method of Agreement and Difference

Mill held that the use of a combination of the method of agreement and the method of difference in order to give the conclusion a higher degree of probability. This method can be systematically represented as:

P Q R S___w x y z. P Q R S __ w x y z

P T U__w u v.   Q R__y z

Therefore, P is the effect, or the cause, or an indispensable part of the cause, of w.

In the above example capital letters denoting circumstances and small letters denote phenomena.

As in this method there is a comparison between two sets of instances, this is also known as indirect method of difference. Mill described it as: "if two or more instances in which the phenomenon occurs have only one circumstance in common, while two or more instances in which it does not occur have nothing in common save the absence of that circumstance; the circumstance in which alone the two sets of instances differ, is the effect, or cause, or a necessary part of the cause, of the phenomenon"

For example: if a certain food when eaten causes pain to somebody and that there is no pain if that food is not eaten, we may doubly sure that the particular food is the cause of the pain.

In this method we compare a variety of situations in which a certain factor is present to similar situations in which that factor is absent. Then show that a certain effect is observed in all and only those instances in which that factor is present.

The Method of Residues

This method is defined as a pattern of inductive inference in which, when some portions of the phenomenon under investigation are known to be the effects of certain identified antecedents, we may conclude that the remaining portion of the phenomenon is the effect of the remaining antecedents. Mill defined this method as “to deduct from any given phenomenon such part as is known by previous inductions to be the effect of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedents”.

Thus if a range of factors are believed to cause a range of phenomenon, and we have matched all the factors, except one, with all the phenomena, except one, then the remaining phenomenon can be attributed to the remaining factor

This method focusing upon residues is well illustrated in the very simple device used to weigh truck cargo's. The weight of the truck when empty is known. To determine the weight of the cargo, the entire truck is weighed with its cargo and the weight of the cargo is then known to be the weight of the whole minus the weight of the truck. The known “antecedents” in Mill’s phrase, is the recorded weight of the empty truck that must be subtracted from the reading on the scale; the cause of the difference between that reading and the known antecedent is obviously attributable to the remaining ‘antecedents’ that is to the cargo itself.

Systematically, the method of residues can be represented as follows:

P Q R__ x y z

Q is known to be the cause of y

R is known to be the cause of z

Therefore, P is the cause of x.

The method of residues differs from other methods in that it can be used with the examination of only one case, while the others require the examination of at least two cases. And the method of residues, unlike the others, appears to depend upon antecedently established causal laws, while the other method does not. This method is inductive because it yields conclusions that are only probable and cannot be validly deduced from their premises. An additional premise or two might transform an inference by the method of residues into a valid deductive argument but that can be said for other inductive methods as well.

The method of concomitant variation

Mill regarding method of concomitant variation wrote that "whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner is either a cause or an effect of that phenomenon or is connected with it through some facts of causation". Mill further argued that concomitant variation is a pattern of inductive inference in which it is concluded that, when one phenomenon varies consistently with some other phenomenon, either directly or inversely, there is some causal relation between the two phenomena.

If across a range of circumstances leading to a phenomenon, some property of the phenomenon varies in cycle with some factor existing in the circumstances, then the phenomenon can be associated with that factor. For instance, suppose that various samples of water, each containing both salt and lead, were found to be toxic. If the level of toxicity varied in cycle with level of lead, one could attribute the toxicity to the presence of lead.

Using plus and minus signs to indicate the greater or lesser degree to which a varying phenomenon is present in a given situation, the method of concomitant variation can be schematized as follows:

P Q R __ x y z

P ± Q R__ x ± y z.

Therefore, P and x are causally connected

The four previous methods thus far discussed are all eliminative in nature. By eliminating some possible cause or causes of a given phenomenon, they support each other causal account hypothesized. The method of agreement eliminates as possible causes those circumstances in whose absence the phenomenon can nevertheless occur; the method of difference permits the elimination of some possible causes by removing an antecedent factor shown to be critical; the joint method is eliminative in both of these ways; and the method of Residues seeks to eliminate as possible causes those circumstances whose effects have already been established by previous inductions.

But there are many situations in which no one of these methods is applicable, because there are circumstances involved that cannot possibly be eliminated. This is often the case in economics, in physics, in medicine, and wherever the general increase or decrease of one factor results in a concomitant increase or decrease of another; the complete elimination of either factor not being feasible.

A farmer establishes that there is a causal relation between the application of fertilizer to the soil and the size of the crop by applying different amounts to different parts of a field, then reading the concomitant variation between the amounts of the additive and the yield. A merchant seeks to verify the efficacy of advertising of different kinds by running varied advertisements at varying intervals, then reading the concomitant increase or decrease of business during some of those periods.

Thus if variations in Phenomenon P coincides with variations in phenomenon Q, then it is probable that P and Q are causally related.

Definitions and its Types

According to Aristotle, a definition is summum genus at differentia, i.e. it has two things. It mentions the class under which the defined term comes and also the distinguishing property which belongs to it and therefore separates it out from other classes. Accordingly, the definition contains two terms; the genus and the differentia. A genus is the essence belonging to a number of things showing differences in kind, the genus of circle; triangle etc is "plane figure". The differentia is that part of essence which distinguishes the species (classes under a genus) from other species in the same genius. The differentia of circle is having all its points equidistant from the centre; the differentia of triangle is being bonded by three straight lines.

Definitions are always definitions of symbols, because only symbols have meanings for definitions to explain.

The word chair we can define, since it has a meaning; but a chair itself we cannot define. We can sit on, paint it etc. but we cannot define it because an actual chair is not a symbol that has meaning to be explained.

The word triangle means a plane figure enclosed by three straight lines or a triangle is (by definition) a plane figure enclosed by three straight lines.

The symbol being defined is called the definiendum; and the symbol or group of symbols used to explain the meaning of the definiendum is called the definiens.

Types of Definitions

Stipulative Definitions

A definition that has meaning which is deliberately assigned to some symbol is called stipulative definition. One who introduces a new symbol is free to assign, or stipulate, whatever meaning he cares to. Even an old term in a new context may also have its present meaning stipulated. Stipulated definitions are sometimes referred to as nominal or verbal definitions.

Terms are introduced by stipulation for many reasons. Convenience is one reason; a single word may stand for many words in a message. Secrecy is another reason, when only the sender and receiver of the message can understand the stipulation. The number equal to a billion trillion (1021) has been named as zetta, and the number equal to trillion trillions (1024) is named as yota.

A stipulative definition is neither true nor false. A stipulative definition is a proposal (or a resolution or a request or an instruction) to use the definiendum to mean what is meant by the definiens. Such a definitions is therefore directive rather than informative. Proposals may be rejected, requests refused, instructions disobeyed but they can be neither true nor false.

Lexical definitions

Lexical definitions are the definitions which have the purpose to explain that use and to eliminate ambiguity are known as lexical definitions. A lexical definition reports a meaning the definiendum already has in actual language usage. That report may be correct or incorrect and it is clear that a lexical definition may be true or false. Thus the definition ‘the word bird means any warm-blooded vertebrate with feathers’ is true; that is a correct report of how the word ‘bird’ is generally used by speakers of English. On the other hand, the definitions ‘the word ‘bird’ means any two-footed mammal is obviously false.

Here lies the fundamental difference between lexical and stipulative definitions; truth or falsity may apply the lexical but not to stipulative. In a stipulative definition the definiendum has no meaning apart from the definition that introduces it, so that the definition cannot be true or false. But the definiendum of a lexical definition does have a prior and independent meaning, and therefore its definition may be true or false, depending on whether that meaning is correctly or incorrectly reported.

Précising definitions

Some terms are ambiguous; some terms are vague. A term is ambiguous in a given context when it has more than one distinct meaning and the context does not make clear, which meaning is intended. A term vague when there are borderline cases to which the term might or might not apply. A word or phrase for example, ‘libel’ or ‘freedom of speech’ may be both ambiguous and vague. Précising definitions are those definitions which are used to clear ambiguity and vagueness.

The vagueness of units of measurement in science is a serious problem. ‘Horsepower’ for example is a term commonly used in reporting the power of motors, but its vagueness invited commercial deception. To overcome that, a precise was needed. ‘one horsepower is equal to power needed to raise a weight of 550 pounds by one foot in one second’ which is calculated to be equal to 745.7 watts.

A precise definition differs from both the lexical and stipulative definitions, it differs from stipulative definitions in that its definiendum is not a new term, but one whose usage is known, although unhappily vague. In constructing a precise definition, therefore, we are not free to assign to the definiendum any meaning we please. Thus precise definition is a report on existing language usage, with additional stipulations provided to reduce vagueness.

Theoretical definitions

When scientists or philosophers criticize one another's definition, it is usually because they are seeking some comprehensive understanding of which the definition, if it is correct, can serve as the summary. Definitions of this kind aim not so much for precision as for theoretical truth. Theoretical definitions are helpful for generating understanding in scientific practice. In Plato's Republic, Socrates and Thrasymachus battle at length over the correct definition of 'justice'. Physicists long battled over the definition of 'heat'. In both the cases, the goal was a coherent theoretical account. The central terms of such accounts require definition. So it was asked: What is justice? What is heat? Thus a theoretical definition of a term is definition that attempts to formulate a theoretical adequate or scientifically useful description of the objects to which the term applies. One theoretical definition may be replaced by another. Therefore, different theoretical definitions like that of justice and heat have been put forward because different theories of justice and heat have been accepted at different times.

Persuasive definitions

Persuasive definitions are those definitions which are meant to influence attitudes or stir emotions. A definition put forward to resolve a dispute by influencing attitudes or stir emotions are known as persuasive definitions.

In political argument, persuasive definitions are common. From the left we hear 'socialism' defined as democracy extended to the economic sphere. From the right we hear 'capitalism' defined as freedom in the economic sphere. The directive intent of the emotive language in these definitions is obvious but emotive coloration may also be injected subtly into wording that purports to be correct lexical definition, and appears on the surface to be that. As we seek to distinguish good reasoning from bad, we must be on guard against persuasive definitions.

Fallacies

There are many types of fallacies as there are many types of errors in arguing. Falsehood has many faces whereas truth has only one. Therefore, our task is clear. What do we mean by fallacy? How do they arise? How are they classified? How can we avoid them? These are some of the questions to which we turn now.

Logic deals with the rules of correct thinking. Hence fallacy arises when we violate any of these rules. Strictly speaking, a fallacy is a type of arguing which appears to be valid, but actually invalid. The term fallacy comes from the Latin word 'fallo', meaning 'I deceive'.

We reason incorrectly when the premises of an argument fail to support its conclusion. Every fallacy can be a Non-sequitur (it does not follow).

(This man is not clever because he cannot hear fast or he is not a bird because he does not wear jeans). This sort of argument is fallacious. Therefore, any kind of error in reasoning is called fallacy. Logicians use term 'fallacy' to mean typical errors that is, mistakes in reasoning that exhibits a pattern that can be identified and named. Fallacies can be detected and logicians are like bees that identify the real flowers otherwise plastic flowers give them the impressions of real flowers.

The great logician Gottlob Frege, regarded as the father of modern logic, has made the observation that one of the tasks of logician is to 'indicate the pitfalls laid by language in the way of the thinker'. The particular argument that violates some known or unknown rule is commonly said to be a fallacy because it is an individual example of that typical mistake. When the rule is known, it is the business of logician to discover or frame the rule.

Most of the fallacies are informal; they are patterns of mistakes that arise from confusions concerning the content of the language used. Such informal fallacies arise in very many ways and they are often more difficult to detect than formal fallacies because language is slippery and imprecise and can set traps. Thus the sources of fallacies in our daily life are misinterpretations, false assumptions, lack of knowledge, distraction of the mind, prejudices and so on.

Fallacies are divided into four classifications

1. Fallacies of Relevance
2. Fallacies of Induction
3. Fallacies of Presumption
4. Fallacies of Ambiguity

Fallacies of Relevance

1. **Appeal to Emotion (Argumentum Ad Populum):** When an argument asserts on making use of feelings and prejudices of people rather than their reason. For example, in campaigning for elections in Kashmir, one might ask: 'Should you not vote for National Conference? Did not Sheikh Abdullah suffer imprisonment for the sake of country? Thus the speaker or writer appeals to patriotism but not to reason. Second example is that even advertisers commit this fallacy when beauty products are associated with women graceful and charming and men handsome and famous. They commit this fallacy because they appeal to emotion without clear evidence to appeal to reason.

2. **The appeal to Pity (Argument ad Misericordiam):** A fallacy in which the argument depend generosity, altruism, or mercy, rather than reason. When the premises of an argument are no more than an appeal to pity, to the heart, the argument is fallacies. This fallacy is a subcategory of appeal to emotion.

3. **The Red Herring:** It is distracting the attention of listeners from the topic under discussion. As the story goes, red herring is used to distract or confuse dogs. It means a trail which is left to mislead deliberately. So whatever can keep the listener off the track may serve as a red herring. In a popular novel and movie, the Da Vinci Code, one of the characters, a Catholic Bishop, enters the plot in ways that cleverly mislead. His name aptly suits the mission; Bishop Arinarosa-meaning 'red herring' in Italian.

4. **The Straw Man:** Is a way of arguing against some view by presenting an opponent's position as one that is easily torn apart. That is, it is very much easier to win a fight against a man made of straw than against one made of flesh and blood. To argue that one should not join the civil services since some civil servants are corrupt and by joining the service one would be supporting this systematic corruption is an example of straw man argument. But this argument is not justifiable because someone may decide to join administration with the laudable intention of eradicating corruption in public life. This fallacy results when we adopt the most extreme view possible-that every act or policy of a certain kind is to be rejected. This argument is easy to win, but not relevant to the conclusion originally proposed.

5. **Argument against the person (Argumentum ad Hominem):** This fallacy consists in attacking the character of the opponent instead of proving or disproving the point at issue, instead of proof, the argument merely refers to his conduct. The thrust of the argument which commits the fallacy of ad hominem is not on the disputed conclusion, but on some person who defends it. This kind of personal attack is hurting, and might be conducted in either of two ways: one is abusive and the other circumstances.

It is a fallacy in which the argument depends on an attack against the person taking a position; an ad hominem attack can be abusive or circumstantial. The phrase, 'ad hominem' translates into 'against the person'.

Abusive attack means 'questioning the integrity of the opponent', but the character of an adversary is logically irrelevant to the truth or falsity of the reasoning employed. A proposal may be attacked as unworthy because it is supported by extremists or by fundamentalists but such allegations even when plausible, are not relevant to the merit of the proposal itself. Socrates was convicted of impiety partly because of his long association with persons known to have been disloyal to Athens and rapacious in conduct.

Circumstantial ad hominem is to argue that you are as bad as I am; just as guilty of whatever it is that you complained about. For example, a hunter, accused of needless slaughter of harmless animals, sometimes replies by noting that his critics eat the flesh of harmless cattle. However, the fact that critics eat the meat is totally irrelevant to the question raised, viz. whether needless killing is ethical.

6. **Appeal to Force (Argument ad Baculum):** A fallacy in which the argument depends on the threat of force; the threat may be veiled. This fallacy consists in appealing to physical force to make the opponent to submit. 'appeal to the stick' is hardly logic, though sometimes very effective, for example, in making the criminals confess their crime. However, no one would agree that 'might is right'. The threat of force in any form is unreasonable and therefore fallacious. Threat is a powerful force and many powerful nations are using this force to impose bans like reducing financial aid, cutting the technical assistances and so on, if the opponent countries do not sign a particular treaty.

7. **Missing the Point (Ignoratio Elenchi):** It is a type of fallacy in which the premises support a different conclusion than the one that is proposed. This fallacy arises when we are diverting attention from the real point at issue. It is arguing beside the point. This fallacy applies to many kinds of arguments where the conclusion does not follow from the premises. Example; the object of war is peace, soldiers are the best peace makers. Even if it is assumed that the object of war is peace, then still it does not imply that soldiers are the best peacemakers. In this fallacy, the premises go in one direction and conclusion in another; the argument misses the point. The reasoning in an ignoratio elenchi literally means 'mistaken proof' or 'mistaken refutation'.

Every fallacy of relevance may be said to be an ignoratio elanch in some sense, because in every fallacy of relevance, the premises misses the point.

Non –Sequitur is a type of fallacy which literally means ‘does not follow’. It is fallacy in which the conclusion does not simply follow from the premises. Non-sequitur is more often applied when the failure of argument is obvious. A great, rough non sequitur Abraham Lincoln observed in a speech in 1854 was sometimes twice as dangerous as a well-polished fallacy.

Fallacies of induction

Fallacies of induction are those fallacies in which the premises are too weak or ineffective to warrant the conclusion.

1. **The argument from ignorance (Argument ad Ignorantium):** A fallacy in which a proposition is held to be true just because it has not been proved false, or false just because it has not been proved true. We know very well that many true propositions have not yet been proved true, and that many false propositions have not yet been proved false and it is therefore plain that our ignorance of how to prove, or disprove, a proposition does not establish its truth or its falsehood. For example: ‘there is neither heaven nor hell because no one has seen it’ or ‘Ghosts do not exist because no one has proved its existence so far’. In both these examples the inferences carried out are defective. Ignorance or absence of evidence is taken as evidence for the conclusion.

2. **The Appeal to Inappropriate Authority (Argument ad Vercundium):** A fallacy in which a conclusion is based on the judgment of a supposed authority who has no legitimate claim to expertise in the matter. The fallacy of the appeal to inappropriate authority arises when the appeal is made to parties having no legitimate claim to authority in the matter at hand. Thus, in an argument about morality an appeal to the opinions of Darwin, a towering authority in biology, would be fallacious, as would be an appeal to the opinions of a great artist such as Picasso to settle an economic dispute. But care must be taken in determining whose authority it is reasonable to depend on, and who’s to reject. While

Picasso was not an economist, his judgment might plausibly be given some weight in a dispute pertaining to the economic value of an artistic masterpiece; and if the role of biology in moral questions were in dispute, Darwin might indeed be an appropriate authority. If a say that 'Magnet is living because Thales says so, then I commit the fallacy of inappropriate authority. One more example is that we known Christiano Ronaldo is authority in football, says a particular car is good, we accept that car is superb. We are committing the fallacy of inappropriate authority because Roaldo is an authority in football but not in cars.

3. **False Cause (Argument non causa pro causa):** A fallacy in which something that is not really a cause is treated as a cause. The fallacy of false cause is committed when two events are causally connected when, in reality, such connection does not exist. This is a very common mistake. Superstition, for example, suffers from this fallacy. Suppose that someone says that a black dog crossed the path of a traveler and shortly afterword's he broke his head and therefore the black cat crossing the path is cause. This is an example of this fallacy.

Fallacy of false cause has further two forms:

Post Hoc Ergo Propter Hoc: 'after the thing, therefore because of the thing'; a type of false cause fallacy in which an event is presumed to have been caused by another event that came before it. Every antecedent of an event is not necessarily the cause of the consequent event. Example: 'thunder is heard after the lightning', therefore lightening is the cause of thunder'. Mistakes of this kind are rather common. Unusual weather conditions are blamed on some unrelated celestial phenomenon that happened to precede them; an infection caused by a virus is thought to be caused by a chill wind, or wet feet, and so on.

Slippery slope: A type of false cause fallacy in which change in a particular direction is assumed to lead inevitably to further disastrous, change in the same direction. False cause is also false committed when one mistakenly argues against some proposal on the ground that any change in a given direction is sure to lead to further changes in the same direction- and thus to grave consequences. Taking this step, it may be said, will put us on a slippery slope to disaster and such reasoning is therefore called the fallacy of the slippery slope.

Hasty Generalization: A fallacy in which one moves carelessly from individual cases to generalization. It is also known as converse accident. Hasty generalization is the fallacy we commit when we draw conclusions about all the persons or things in a given class on the basis of our knowledge about only one (or only a very few) of the members of that class. We all know of persons who have generalized mistakenly about certain companies or governments because of a single experience. Stereotypes about people who come from certain countries or cultures are widespread and commonly mistaken; hasty generalization about foreign cultures can be downright nasty, and are good illustrations of the fallacious leap to broad generalization on the basis of very little evidence.

Fallacies of Presumption

Fallacies in which the conclusion depends on tacit assumption that is dubious, un-warranted, or false.

1. **Accident:** A fallacy in which a generalization is wrongly applied to a particular case. Accident arises due to lack of clarity regarding the meaning of terms used. It has two forms.

Direct or simple fallacy of accident consists in arguing that what is true of a thing under normal circumstances is also true of it under special circumstances. Consider this example; ‘Freedom is the birth right of man; so no one should be imprisoned’. This is ordinarily true but it is not applicable to a man who has committed a serious crime. Another example is more educative. ‘Such and such a person should be fined for ignoring a ‘No swimming’ sign when the purpose of jumping into water is to rescue someone from drowning’.

The converse fallacy of accident is the opposite of the direct fallacy of accident. It occurs when we argue that what is true of a thing under special circumstances is also true under normal circumstances. Consider this example. ‘Liquor is beneficial in certain cases of diseases; they must, therefore, be beneficial for all persons and so its prohibitions must be lifted’. This is similar to hasty generalization.

2. **Begging the question (Petitio Principii or Circular Argument):** A fallacy in which the conclusion is stated or assumed within one of the premises. This fallacy consists in cleverly assuming the conclusion in the premises instead of proving it. Example: ‘I should not do this because it is wrong’. This argument does not prove why the action is wrong but merely assumes it to be evil. Thus, if we assume what needs proof, then we are mere beggars, begging what we ought to earn by proof. This fallacy ends where it begins.

J. S. Mill argued that categorical syllogism commits the fallacy of petition principii. For example, consider the argument:

All mangoes are sweet

Alphanso are mangoes

Therefore, Alphanso’s are sweet

Here in the above argument while establishing the truth of the premises, the conclusion is already taken into account. Without disputing this comment, let us take a non-syllogistic argument committing this fallacy: A man registered a women in a hotel as his wife and replied, when asked for proof, ‘certainly she is my wife because I am her husband.

3. **Fallacy of Complex Question:** It is also known as fallacy of many questions. It is a deceitful device. This fallacy consists in asking a question in such a way as to presuppose the truth of some proposition buried in the question. This is a favorite device of layers. For instance, a lawyer asks a defendant: ‘have you stopped torturing your wife’. It assumes that you are married, and that your wife is alive, and that you used to torture your wife, and so on. But none of these may be the case. The truth may be that you are a bachelor. The best way to face this

fallacy is to refute all the presuppositions hidden in the question one by one, instead of giving a straight yes or no answer which might land you in trouble.

Fallacies of Ambiguity

These fallacies arise as a result of the shift of meaning of words and phrases, shift from the meanings that they have in the premises to different meanings ascribed to them in the conclusion. Such mistakes are called fallacies of ambiguity. Or simply we can say that fallacies caused by a shift or confusion of meanings within an argument. The deliberate use of such devices is usually crude and readily detected; but at times the ambiguity may be obscure, the error accidental, and the fallacy subtle. There are five varieties of such kind discussed below:

1. **Equivocation:** Equivocation is a fallacy in which two or more meanings of a word or phrase are used in different parts of an argument. It is the fallacy which consists in using words or phrases with two or more meanings, deliberately or accidently, while formulating an argument. There are many words like, right, left, pleasure, good, Beauty, truth, etc. which have more than one meaning and if they are used in their different sense in the premises and conclusion, reasoning will obviously be fallacious. For example:

Apples are good

Good is the aim of man’s life

:. The aim of man’s life is apples

Obviously, in the major premise ‘good’ does not mean the same as in the minor.

2. **Amphiboly:** A fallacy in which a loose or awkward combination of words can be interpreted more than one way; the argument contains a premise based on one interpretation while the conclusion depends on a different interpretation. Amphiboly is ambiguity in phrasing. For example, if someone is told that by gambling he will make a fortune, this may mean he will make his own fortune by winning heavily or will make

someone else's fortune by loosing heavily. A story is told about a sage who told someone that his son will have cars all around him and finally his son fulfilled his prophecy when the son became a traffic policeman. An amphiboly statement may be true in one interpretation and false in another. When it is stated as premise with the interpretation that makes it true, and a conclusion is drawn from it on the interpretation that makes it false.

3. **Composition:** A fallacy in which an inference is mistakenly drawn from the attributes of the parts of a whole, to the attributes of the whole. This is the fallacy due to taking a 'collective term' in the sense of 'distributive term'. For example:

   All who die in war are brave

   All army men are brave

   Therefore, All army men die in war

   Here the term 'all' of major premise means 'anyone' and in conclusion of 'everyone'.

4. **Accent:** A fallacy in which a phrase is used to convey two different meanings within an argument and the difference is based on changes in emphasis given to words within the phrase. When a premise depends for the apparent meaning on one possible emphasis, but a conclusion is drawn from it that relies on the meaning of the same words accented differently, the fallacy of accent is committed

Consider the example, the different meanings that can be given to the statement:

'We should not speak ill of our friends'.

5. **Division:** A fallacy in which a mistaken inference is drawn from the attributes of a whole to the attributes of the parts of the whole. The fallacy of division is the reverse of the fallacy of composition. In division we argue (mistakenly) that, since the calls itself has a given attribute, each of its members also has it. Thus, it is the

fallacy of division to conclude that, because any army as a whole is nearly invincible, each of its units is nearly invincible.

White Kashmiries are disappearing

He is a white Kashmiri

Therefore, He is disappearing.

Obviously, what is true in a collective sense does not apply to each member of the collection.

Another example is

Dogs are frequently encountered in the streets

German Shepherds are dogs

Therefore, German Shepherds are frequently encountered in the streets.

Circularity

A type of reasoning in which the proposition is supported by the premises, which is supported by the proposition, creating a circle in reasoning which no useful information is being shared.

If A then B,

If B, then A.

Circular reasoning is when you attempt to make an argument by beginning with an assumption that what you are trying to prove is already true. In your promise, you already accept the truth of the claim you are attempting to make. It sounds complicated, but it is easily understood with some real world examples.

X is true because of Y

Y is true because of X.

It is also known as Paradoxical thinking, Circular argument, Circular cause, reasoning in a circle and Vicious circle.

God exists→why should I believe that →because Bible says that God exists→why should I believe anything that Bible says→Because Bible is the inspired word of God→that is why God exists

Circular reasoning may sound convincing, but consider who will most likely be convinced by a circular argument. Those who already accept the argument as true are more likely to be further convinced. This is because they already believe the assumption that is stated.

Example 1:

The Bible is true, so you should not doubt the word of God.

This argument rests on your prior acceptance of the Bible as truth.

Example 2:

Women should be able to choose to terminate a pregnancy, so abortion should be legal.

This argument says abortion should be legal because women have right to an abortion.

Circular reasoning occurs when the end of an argument comes back to the beginning without having proven itself. This form of reasoning is considered a pragmatic defect, or informal fallacy.

A proves B. However, unlike a logical argument, B depends on A to be true, causing the statement to loop back around.

Circular reasoning is also known as circular questioning or Circular hypothesis. It can be easily to spot because both sides of the argument are essentially making the same point. For example:

Example: What comes first, the chicken or egg

Explanation: A chicken must come from an egg, but, an egg cannot exist without a chicken laying it. But a chicken must come from an egg.

Other examples of Circular Reasoning are

6. Everyone loves Katrina, because she is so popular

7. Elif Shafak's new book is well written, because She is a wonderful writer.
8. Canada is the best place to live, because it is better than any other country.
9. Violent video games cause teens to be violent, because violent teens play violent video games.

Category mistake

A category mistake is a semantic or ontological error in which things belonging to a particular category are presented as if they belong to a different category or alternatively, a property is ascribed to a thing that could not possibly have that property. For example, a person learning that a game of a cricket involves team spirit, and after starting a demonstration of each player's role, asking which player performs the 'team spirit'. So, team spirit is not a task in the game like bowling or bating, but an aspect of how the team behaves as a group.

Category mistake is the term used by Gilbert Ryle in his work, Concept of Mind. Ryle argued that it was a mistake to treat the mind as an object made of an immaterial substance because predications of substance are not meaningful for a collection of dispositions and capacities. The fact 'Saturday is in bed' is a Category mistake while Gilbert Ryle is in bed is not a Category mistake, shows that Saturday and Ryle belongs to different ontological categories.

Suppose a person visits Oxford University, the visitor after viewing the colleges, library, conference hall, said that where is the university? The visitor's mistake is presuming that a university is part of the category "units of physical infrastructure" rather than that of an "institution". Another example is of a child witnessing the march-past of a division of soldiers. After seeing the Battalions, Batteries, Squadrons, etc., asks the question when is the division going to appear. The march-past was not a parade of battalions, batteries, squadrons and a division; it was a parade of the battalions, batteries, and squadrons of a division.

Following are the sentences that designates category mistake

The number two is a blue

The theory of relativity is eating breakfast

Green ideas sleep furiously

Plato is a prime number

CHAPTER – V
MATHEMATICAL LOGIC
(SYMBOLIC LOGIC)

Symbolic logic is the part of logic which deals with the statements of certainty and precision. It is also known as modern logic or mathematical logic. Human thoughts are presented in language but the language which we speak is full of errors and ambiguities. Logicians are the people of wisdom they devised symbolic language in order to make language clear and definite. In symbolic logic, we represent linguistic items with symbols and numerals. If we assume that 'This is a beautiful park' we are not certain about its truth but if we take the statement 'Srinagar is the capital of Jammu and Kashmir' we can easily claim its truth with accuracy and fairness. Thus it is role of symbolic logic to analyze language into mathematical symbols and different mathematical operations can be utilized to prove the validity and invalidity.

The use of symbols is helpful to avoid peripheral linguistic diversities and also to minimize the space and time needed for writing. It further helps to restrict the attention needed for grasping the meaning of long sentences or equations, and so on. This distinct advantage explains why various sciences have developed their own symbolic language. thus for example, in mathematics the equation AxAxAxAxAxAxAxAxAxAxAxAxAxAxA = BxBxBxBxBxBxBxBxBxB is expressed more briefly and reasonably as A15= B10. Logic has developed technical notations to achieve the goal. Aristotle used certain abbreviations to facilitate his own investigators. But then these are symbols which can perform only at elementary level, for that matter all terms are symbols only. Therefore, what matters is the performative ability of symbols.

Modern logic has introduced many more symbols. Such a step enabled logicians to simplify the most complex argument. Simplicity does not mean that something is devoid of content. It only means that an argument is capable of being tested with minimum number of rules and within shortest possible time. In fact accomplishment of this task requires something like creativity. What is the value of all this exercise, it may be asked. The answer is simple. When mistake are easily detected, they are less likely to be made.

Historical Contribution to Symbolic Logic

The famous contribution of Aristotle's contribution to logic, clearly is his theory of syllogism in which the theory of classes and class relation is implicit. Another significant contribution of Aristotle is his idea of Variables. Classes themselves are variables in the sense that in any proposition subject and predicate terms are not only variables but also they are the symbols of classes. Finally the class relation which is explicit in his four-fold analysis of categorical proposition, is understood as inclusion or exclusion which is either total or partial.

A school of thought flourished during the time of Socrates period known as Megarians. The first generation of Megarians flourished in the 5th century B.C. onwards. In the 4th century B.C. one Megarian by the name Eubulides of Miletus (Founder of Megarian School and Student of Eculid) had introduced famous paradox known as 'Paradox of Liar'. The last Greek logician whose none of his works exists. Who is worthy of consideration is Chrysippus of whom it is said that even gods would have used the logic of Chrysippus if they had to use logic.

Peter Abelard, who lived in the 11th century, is generally regarded as the first important logician of medieval age followed by William of Sherwood and Peter of Spain in the 13th century. They continued the work of Aristotle on categorical proposition and syllogism and other related topics. In reality no vacuum was created in medieval age and hence there was continuity from Aristotelian logic to modern logic though no original contribution came from any logician. The most notable contribution to logic in this period consists in the development which took place in several important fields like analysis of Semantics and Syntax of natural language, theories of reference, and application, philosophy of mind, Philosophy of language etc. The relevance of which was, perhaps realized only very recently. These are precisely some of the topics of the modern logic. William of Sherwood and peter of Spain were the first to the first to make the distinction between descriptive and non-descriptive functions of language. They reserved the word 'Term' only for descriptive function. There are three kinds of Terms; Categorematic, Syncategorematic and Acategorematic, where categorematic terms are those words which represents a class like Man, Goat, Humans etc., Syncategorematic terms are those words which are not words in isolation but when these words are placed with other words, it constitutes term like All, Some, No, Alexander the Great, 'John the Baptist' and so on., Acategorematic words can never be terms like Ohhh, Heehee, Booooo, Hip Hip Huraay etc.,

Before we enter the modern era, one interesting question must be considered. How should we explain the relation between logic, language and mathematics? Three philosophers have differently described this relation. Raymond Wilder says that for Peano and his followers 'Logic was the servant of mathematics'. Wilder put it in a more respectable and accepted form, in connection with Frege's philosophy of mathematics, 'mathematics depends upon logic….was more like that of child to parent than servant to master. Wittgenstein and Carnap regards that 'language can be represented in mathematical form so that it can be prevented from errors and ambiguities'. In the first place, a significant number of words are equivocal and secondly, many times the construction of sentences and their juxtaposition are misleading so much so they convey meaning very different from what speaker or author intends. Replacement of words by symbols and application of logical syntax different from grammatical syntax completely eliminates ambiguity. The meaning of logical syntax becomes clear in due course when sentences are represented by symbols. It is possible to test the validity of argument only when the statements are unambiguous. Moreover, use of symbols saves time and effort required to test the validity of arguments.

Symbolic language is the development of Aristotelian logic. Aristotle has introduced into logic the important notions of Variable and Form.

Symbols

There are two types of symbols used in symbolic logic one is logical variable and other is logical connectives. The propositions A, E, I O are denoted by variables p, q, r, s and the logical constants like ‘and’, ‘not’, ‘either…or’, ‘if…. then’, ‘if and only if’ are denoted by ‘•’, ‘¬’, ‘v’, ‘⊃’, ‘≡’. Suppose the proposition ‘All men are Biped’ is represented by p and its contradiction ‘All men are not Biped’ is represented by ¬p. Thus we can denote propositional variable indefinitely and can ascertain the truth value with the help of truth functions. Some functions are made up of compound propositions while others are made up of simple propositions.6 ‘Grass is green’ is denoted by p is simple proposition where as ‘Grass is green and is present in wet lands’ is compound proposition which is denoted by ‘p.q’. Compound propositions are joined with the help of sentential connectives like ‘Not’, ‘And’, ‘Either…or’, ‘If…then’, and ‘If and only If’. Now we will discuss truth functions with their truth tables.

Truth table Technique

A proposition can be either true or false T/F or (1/0) are termed as values of a proposition. The truth values of a compound proposition is determined by the truth values of its constituents. The truth functions of a compound proposition require three columns and if the number of variable is more than one, the number of columns will be number of columns divided by number of functions

No. of columns = No. of variables / No. of functions.

The number of rows is determined by squaring 2 to the number of variables. If we have two variables then the number of rows will be four and if three then the number of rows will be eight,

The formula for drawing number of rows is 2n where n is the no. of variables

Negation

Negation is a Monadic logical operator which is used for a singular function. Negation is denoted by Curl or Tilde (¬). Negation includes those propositions which are in the form of

[6] Simple proposition is a proposition which contains one subject and predicate where as compound proposition is a proposition which is made up of more than one singular proposition.

(Not), (it is not the case that), (it is a not true), (it is a contradiction), (No), (Never) and so on. If we take the example like

Stones are black is a statement and its negation is stones are not black.

Stones are Black is represented by p

Stones are not black is represented by Not-p

So in negation, sentences contains Not-operator

Thus if p stands for ‘Philosophers are Thinkers’

Then ¬ p stands for ‘Philosophers are not Thinkers’

And if p is true then ¬ p is false

Similarly, if ¬ p is true then p is false

Truth table for Negation

The proposition ‘one is a rational number’ is denoted by p

‘One is not a rational number’ is denoted by ¬ p

P	¬ p
T	F
F	T

P	¬ p
1	0
0	1

Note: I have devised two truth tables for negation, one is in sentential form and other is in binary style.

Conjunction

A conjunction is a truth functional compound proposition which combines two propositions with help of the logical connective ‘and’. It is denoted by ‘.’ (dot). The statements which contains logical operator ‘And’ are known as conjunction.

Roses are Red is a conjunct which is denoted by p

Roses are fragrant is another conjunct which is denoted by q

Thus Roses are Red and Roses are Fragrant is denoted by p.q

p stands for Earth is a Planet

q stands for Earth is in Space

p.q stands for Earth is a planet and it is in Space.

According to conjunction, if both of its conjuncts are true then their conjunction is true and if one of the conjuncts is false then their conjunction is false

Thus p is true and q is true, p.q is true

p is true and q is false, p.q is false

p is false and q is true, p.q is false

p is false and q is false, p.q is false

Truth Table for Conjunction

P Conjunct	**q Conjunct**	**p.q Conjunction**
T	**T**	**T**
T	**F**	**F**
F	**T**	**F**
F	**F**	**F**

P Conjunct	q Conjunct	p.q Conjuction
1	1	1
1	0	0
0	1	0
0	0	0

Disjunction

A disjunction is a truth functional compound statement in which two statements are combined with the logical connective 'Either…. or'. Disjunction is symbolized by wedge or vee 'v'. It is also called Alternation. Disjunction is used in two senses; Inclusive sense (weak sense) and Exclusive sense (strong sense).

Inclusive sense (weak sense): In inclusive sense compound propositions are joined with the connective 'or'. Here both the disjunction is true and their disjunction.

Plato is an idealist which is denoted by p

Plato is a philosopher which is denoted by q

Now these two statements can be written in disjunctive from as

Plato is an idealist or a Philosopher which is denoted by pvq

Here in case of inclusive sense

If p is true q is true then pvq is true

It implies pvq is true when both the disjunctive components are true.

Other examples of weak sense are

Aristotle is either a logician or a Biologist pvq

Earth is either a planet or a globe pvq

Apples are sweet or bitter pvq

Books are either costly or cheap pvq

Mudasir is either a writer or a philosopher pvq

Exclusive sense (Strong Sense): In exclusive sense two propositions are connected with the help of logical connective ‘either…or’ but in this case disjunction is symbolized as ‘$\wedge$’ Cap. Thus in case of strong sense both the statements cannot be true one must be false.

Plato is a philosopher which is denoted by p

Plato is a musician which denoted by q

Now these two statements can be written in disjunctive from as

Plato is a philosopher or a musician which is denoted by $p \wedge q$

Here in case of exclusive sense

If p is true q is false then $p \wedge q$ is true

It implies $p \wedge q$ is true when either of the disjunctive components are true but not both

Other examples of strong sense are

Granite stones are either hard or soft $p \wedge q$

Matter either occupies space or it occupies direction $p \wedge q$

Either earth is a Square shaped or a circular $p \wedge q$

X is either beautiful or ugly $p \wedge q$

Numbers are either rational or irrational $p \wedge q$

Mudasir is either a man or a bird $p \wedge q$

Truth Table for Disjunction

P Disjunct	**q Disjunct**	**Pvq Disjunction**
T	**T**	**T**
T	**F**	**T**
F	**T**	**T**
F	**F**	**F**

P Disjunct	q Disjunct	Pvq Disjunction
1	1	1
1	0	1
0	1	1
0	0	0

Material Implication

Material implication is a truth functional compound proposition in which two conditional statements are connected with the logical connective 'if…then'. The propositions explored in this material implication are conditional statements. Implication is a compound statement which is in the form of 'if..then'. It is denoted by '⊃' Horse Shoe and also by implication symbol '→'. In case of 'if…then', (If) part of a compound statement is known as antecedent and (Then) part of compound proposition is known as consequent.

If Ram works hard then will pass the final examination p→q

If He is an Indian then he is a Aligarian p→q

If it burn then it hurts p→q

If the stars are self-luminous then the glass is fragile p→q

If there is rise in temperature then there is rise in mercury level p→q

Now according the rule, a material implication is false only if the antecedent is true and the consequent is false.

If 2 is less than 4 then 2 is less than 6

Here both the antecedent and consequent are true and their implication is also true.

If 5 is less than 4 then 5 is less than 6

Here antecedent is false and consequent is true and their implication is true

If 5 is less than 4 then 5 is less than 5

Here both the antecedent and consequent are false and their implication is true

Truth Table for Material Implication

P Antecedent	q Consequent	p→q Implication
T	T	T
T	F	F
F	T	T
F	F	T

P **Antecedent**	**q** **Consequent**	**p→q** **Implication**
1	**1**	**1**
1	**0**	**0**
0	**1**	**1**
0	**0**	**1**

Material Equivalence

Material equivalence is denoted by '≡' Tribar. It is also known as bi-conditional compound statement. Material equivalence is a truth functional compound proposition in which two statements are connected together with the logical operator 'if and only if'. The statements which are in the form of 'if and only if' are known as bi-conditional compound statements. It is also denoted by bi-conditional symbol '↔'.

Material equivalence is the truth functional connective that asserts that the statement it connects have the same truth value. Two statements that are equivalent in truth value, therefore, are materially equivalent. One straightforward definition is this; two statements are materially equivalent when they are both true, and both be false.

Examples of material equivalence are

A rectangle is a square if and only if it four sides are equal p≡q

If and only if he is married, he cannot be single p≡q

It is false that if and only if John is not an adult, then he is a minor p≡q

If and only if it is not a straight then it cannot be a shortest distance between two points p≡q

Truth Table for Material Equivalence

P **Bi-Conditional**	**q** **Bi-Conditional**	**p≡q** **Equivalence**
T	**T**	**T**
T	**F**	**F**
F	**T**	**F**
F	**F**	**T**

P **Bi-Conditional**	**q** **Bi-Conditional**	**p≡q** **Equivalence**
T	**T**	**1**
T	**F**	**0**
F	**T**	**0**
F	**F**	**1**

Four Truth Functional Connectives

Truth functional connective	**Symbols**	**Statement type**	**Name of the constituents of statement**	**Example**
And	**• (dot)**	**Conjunction**	**Conjuncts**	**Plato is an idealist and Aristotle is a realist**
Or	**v (vee)**	**Disjunction**	**Disjuncts**	**John Dewey is a pragmatist or an Empiricist**
If….then	**⊃(horse shoe)**	**Conditional**	**Antecedent** **consequent**	**If suns rise then photosynthesis occurs**
If and only if	**≡ (tribar)**	**Biconditional**	**Biconditional** **Components**	**A rectangle is a square if and only if its four sides are equal**
Not	**¬ curl**	**Simple**	**Monadic logical operator 7**	**It is not the true that Earth is Square shaped**

Argument and Argument forms and their Truth Tables

An argument is the set of premises which is either valid or invalid. We can also describe that argument is the group of premise which are in the standard form. It is a set of premises where one sentence is claimed to follow from others, which are regarded as providing conclusive evidence for its truth. Every argument has a structure that is premises and conclusion and premises provide support in the derivation of conclusion.

[7]**Not** is not a connective but it is a logical operator having simple propositions. I have used this in the above table only as an operator as well as truth function.

Therefore, premises can be treated as evidence for the inference of conclusion. All arguments involve the claim that their premises provide evidence for the truth of conclusion. But it is important to note that only deductive argument claims that the premises provide absolutely conclusive evidences for the truth of the conclusion. This is the reason why deductive arguments are characterized as valid and invalid. Our main concern is with deductive arguments and not about inductive argument. A deductive argument is valid when the premises and the conclusion are so related as it is impossible for the premises to be true unless the conclusion is true also.

Argument form is the symbolic representation of an argument. In argument form we are attaching symbols to the argument in order to know whether the argument is valid or invalid. Let's take an example

If am a scientist then I am famous

I am not a scientist

Therefore, I am not famous

Another example: If Chomsky is Linguist then Chomsky is famous

Chomsky is not Linguist

Therefore Chomsky is not famous

Invalid argument: An argument that has at least one substitution instances with true premises and false conclusion

Valid argument: An argument form that has no substitution instances with true premises and a false conclusion

Truth Table: An array on which the validity of an argument form may be tested through the display of all possible combinations of the truth values of the statement variables contained in that form.

Common argument forms

Disjunctive Syllogism (D.S)

A Valid argument form in which one premise is a disjunction and another premise is the denial of one of its two disjuncts, and conclusion is the assertion of its other disjunct.

p v q

~ p

:. q

P	**Q**	**pvq**	**~ p**
T	**T**	**T**	**F**
T	**F**	**T**	**F**
F	**T**	**T**	**T**
F	**F**	**F**	**T**

Example

Either the scientific theories are accurate or there is a chance for their improvement
The scientific theories are not accurate
Therefore, there is a chance for improvement

S v I

~ S

:. I

S	**I**	**SvI**	**~ S**
1	**1**	**1**	**0**
1	**0**	**1**	**0**
0	**1**	**1**	**1**
0	**0**	**0**	**1**

Modus Ponens (M.P)

A valid argument form that relies upon a conditional premise and in which another premise affirms the antecedent of that conditional while the conclusion affirms its consequent

$$p \rightarrow q$$

$$p$$

$$\therefore q$$

Example

If he is Indian then he is Asian I→A

He is Indian I

:. He is Asian :. A

Truth Table for Modus Ponens

P	**Q**	**p→q**
T	**T**	**T**
T	**F**	**F**
F	**T**	**T**
F	**F**	**T**

Modus Tollens (M.T)

A valid argument that depends upon a conditional premise and on which another premise denies the consequent of that conditional and the conclusion denies the antecedent.

The argument can be symbolized as

$$p \rightarrow q$$

$$\sim q$$

$$\therefore \sim p$$

Example

If the voters cast their votes, then people could choose their government V→G

People has not chosen their government ~G

Therefore, voters has not cast their votes: ~V

P	Q	p→q	~ q	~p
T	T	T	F	F
T	F	F	T	F
F	T	T	F	T
F	F	T	T	T

Hypothetical Syllogism (H.S)

It is the argument form in which two conditional propositions are such that the consequent of the first statement is the antecedent of the second, we can draw another conditional statements as the conclusion in which we have the antecedent of the first statement and the consequent of the second. This inference is of the form

$$p \rightarrow q$$

$$q \rightarrow r$$

$$\therefore p \rightarrow q$$

Example

If the voters cast their votes, then people could choose their government

If people could choose their government then there will be development in the state

Therefore, if the voters cast their votes then there will be development in the state

Example

If David will appear in the final examination, then he will complete his bachelor's degree

If he will complete his bachelor's degree then he will apply for administrative service exams

If David will appear in the final examination, then he will apply for administrative service exams

Truth table for Hypothetical Syllogism (H.S)

P	Q	R	$p \rightarrow q$	$q \rightarrow r$	$p \rightarrow q$
T	T	T	T	T	T
T	T	F	T	F	F
T	F	T	F	T	T
T	F	F	F	T	F
F	T	T	T	T	T
F	T	F	T	F	T
F	F	T	T	T	T
F	F	F	T	T	T

Rule of Construction Dilemma (C.D)

Two conditional statements or propositions joined by conjunction. Thus by this rule, if two conditional statements are jointly true and their antecedents are true then their consequents are also true. This argument is symbolized as

$(p \rightarrow q) \bullet (r \rightarrow s)$

P v r

:. q v s

Destructive Dilemma (D.D)

In destructive dilemma two premise are required to make it argument

1. Two conditional propositions joined by conjunction
2. A disjunctive statement which consists of the negation of the consequent of the same conditional propositions (in the first premise) as its disjuncts.

Thus by this rule, if two conditional statements are jointly true and their consequent are false. Their antecedents are also false. The form of this argument is symbolized as

$(p \rightarrow q) \bullet (r \rightarrow s)$

$\sim q \vee \sim s$

$\therefore \sim p \vee \sim r$

Rule of Simplification (Simp.)

If a true conjunctive statement is given, we can infer the first conjunct as the conclusion. This argument form is symbolized as

$p \bullet q$

$\therefore p$

Example

He threw stone on water and the water scattered on his face

Therefore, he threw stones on water

Apples are sweet fruits and apples contains vitamins

Therefore, apples are sweet fruits

Rule of conjunction (Conj.)

According to this rule, any true statement is conjoined with another true statement and by conjoining we get a conjunctive statement. Example of this rule is "John is hard worker" is one true statement while other statement is "John likes study". So by conjoining these two statements we get a conjunction.

John is hard worker and likes study

This argument form is represented as

p

q

:. p . q

Rule of Addition (Add.)

If a statement is true we can add disjunctively another proposition which may be either true or false. Even if a false statement is added, the truth value of the disjunctive statement cannot change because in a true disjunctive statement at least one of the disjuncts is required to be true. This argument form can be symbolized as

p

:. p v q

Rules of inference (Valid Argument Forms)

Name of the argument	**Representation**	**Argument form**
Modus Ponens	**M.P**	**P→Q** **P** **:. Q**
Modus Tollens	**M.T**	**P→Q** **~Q** **:. ~P**
Hypothetical Syllogism	**H.S**	**P→Q** **Q→R** **:. P→R**
Disjunctive Syllogism	**D.S**	**P v Q** **~P**

		:. Q
Constructive Dilemma	**C.D**	**(P→Q) • (R→S)** **P v Q** **:. Q v S**
Destructive Dilemma	**D.D**	**(P→Q) • (R→S)** **~Q v ~S** **:. ~P v ~S**
Simplification	**Simp.**	**P • Q** **:. P**
Conjunction	**Conj.**	**P** **Q** **:. P • Q**
Addition	**Add.**	**P** **:. P v Q**

Rules of replacement (Logically Equivalent Forms)

Name of the argument	Representation	Argument form
De Morgans's Law	**De M.**	**~ (p • q) ≡ (~ p • ~ q)** **~ (p v q) ≡ (~ p • ~ q)**
Commutation Law	**Com.**	**(p v q) ≡ (q v p)** **(p • q) ≡ (q • p)** **a x b = b x a**

		a +b =b+ a
Double Negation	**D.N**	**p ≡ ~ ~ p**
Transposition	**Trans.**	**(p → q) ≡ (~ q → ~ p)**
Material Implication	**Impl.**	**(p → q) ≡ ~ p v q**
Material Equivalence	**Equiv.**	**(p ↔ q) ≡ {(p → q) • (q → p)}** **(p ↔ q) ≡ {(p • q) v (~ p • ~ q)}**
Exportation	**Exp.**	**{(p • q) → r} ≡ {(p →(q→r)}**
Tautology	**Taut.**	**p ≡ (p v p)** **p ≡ (p • p)**
Association	**Ass.**	**{p v(q v r)} ≡ {(p v q) v r}** **{p • (q • r)} ≡ {(p • q) • r}** **a x (b x c) = (a x b) x c** **a+(b + c) = (a + b) + c**
Distribution	**Dist.**	**{p • (q v r)} ≡ {p • q) v (p • r)}** **{p v (q • r)} ≡ {p v q) • (p v r)}** **a + (b x c) = (a + b) x (a + c)** **a x (b + c) = (a x b) + (a x c)**

Statement forms and Statements

Tautology

A tautology is a truth functional propositional form which is true under all truth possibilities of its components. Whether given statements form is a tautology or not can be easily determined by constructing a truth table for a given statement form. A scrutiny of the truth values under the main connective is sufficient to label the schema as a tautology or not. Hence if we find only T's and no F's on the main operator (truth function) then the schema is a tautology. Nevertheless, if we find only a single F under the main connective then the schema is not a tautology. We can illustrate with truth table for this statement form as

p v ~ p

Example: Either Ifrah is a beautiful girl or she is not beautiful

Truth table for Tautology

No. of rows	**Matrix**	**Truth-function**			
	P	**p**	**v**	**~**	**p**
1	**T**	**F**	**T**	**F**	**T**
2	**F**	**T**	**T**	**F**	**F**

No. of rows	**Matrix**	**Truth-function**			
	P	**p**	**v**	**~**	**p**
1	**1**	**0**	**1**	**0**	**1**
2	**0**	**1**	**1**	**0**	**0**

In the above truth table, we found all T's and no F's under the main connective v. Thus the statement is a tautology. Tautology is a valid statement form but not all valid statement forms are tautologies. Hence negation of tautology results in contradiction.

The following statement forms are tautology

P → (P v Q)

P v (P→Q)

~ (P•~ P)

Contradiction

A statement form which is false for all possible truth values of its statement letters is called a contradiction. A contradiction is a truth functional statement form which is false under all the truth possibilities of its components. If a scrutiny of the truth values under the main operator shows all F's and no T's then the schema is a contradiction. A contradiction takes only the value F in its main connective. Now we shall construct a truth table for contradiction

~ (p → p)

No. of rows	**Matrix**	**Truth-function**			
	P	**~**	**(p**	**→**	**p)**
1	**T**	**F**	**T**	**T**	**T**
2	**F**	**F**	**F**	**T**	**F**

No. of rows	**Matrix**	**Truth-function**
	P	**~ (p → p)**

1	**1**	**0**	**1**	**1**	**1**
2	**0**	**0**	**0**	**1**	**0**

It appears that under the main connective there are all F's and no T's. So the given statement is a contradiction. It is also called inconsistent schema. It is an invalid statement form. Nevertheless, denial of contradiction results in tautology. Thus in simple language we can say that a statement form which is always false is called contradiction.

Following propositions are contradictions

P • ~ P   (Connective is •)

~ (P v ~ P)   (Connective is ~)

(P v ~ P) → (Q • ~ P)   (Connective is →)

Truth table for above contradictions

P • ~ P

P	**P**	**•**	**~**	**P**
T	**T**	**F**	**F**	**T**
F	**F**	**F**	**T**	**F**

~ (P v ~ P)

P	**~**	**P**	**v**	**~P**
T	**F**	**T**	**T**	**F**
F	**F**	**F**	**T**	**T**

(P v ~ P) → (Q • ~ P)

P	**q**	**(P v ~Q)**				**→**	**Q**	**•**	**~ P**
T	**T**	**T**	**F**	**F**	**T**	**F**	**T**	**T**	**F**
T	**F**	**T**	**T**	**T**	**F**	**F**	**F**	**F**	**F**
F	**T**	**F**	**F**	**F**	**T**	**F**	**T**	**T**	**T**
F	**F**	**F**	**F**	**T**	**F**	**F**	**F**	**T**	**T**

Contingency

A contingency is true under some truth possibilities of its components and false under other truth possibilities. It is s statement form which is neither a tautology nor contradiction. The main column of its truth table indicates at least one 'T' and at least one 'F'. Thus we find a combination of T's and F's under the main operator. This can be well explained with the following truth table

(p • ~ q)

p	**q**	**(P • ~ Q)**			
T	**T**	**T**	**F**	**F**	**T**
T	**F**	**T**	**T**	**T**	**F**
F	**T**	**F**	**F**	**F**	**T**
F	**F**	**F**	**F**	**T**	**F**

Contingents are invalid statements forms. Negation of contingency results in contingency itself and other contingencies are

(~ p→q)

$(\sim p \rightarrow q) \equiv (q \rightarrow \sim p)$[8]

[8] Note: if ~ is placed in the bracket then it is not considered as a connective but if it is placed outside of bracket then it is considered as a connective.

CHAPTER - VI
PREDICATE LOGIC

(QUANTIFICATION LOGIC)

Predicate logic

Predicate logic is a branch of logic which deals with the study of predicates or with the properties of properties. It also deals with those things or objects to which the predicates may be ascribed. Predicate logic was invented by German logician Gottlob Frege. Predicate logic is also known as first-order predicate calculus[9] or predicate logic. It is a collection of formal systems used in mathematics. Predicate logic is the extension of propositional logic. However, in mathematical logic, a predicate is commonly understood to be a Boolean – valued function P: X→ (true, false), called the predicate on X. Predicate logic is also known as logic of quantifiers (Quantification Logic) and in which quantifiers are employed to denote the propositions. It is a part of modern formal or symbolic logic which systematically shows the logical relations between sentences that hold purely in virtue of the manners in which predicate expressions are distributed through ranges of subjects by means of quantifiers such as 'all' and 'some' without regard to the meanings or conceptual contents of any predicates in particular. Such predicates can include both qualities and relations and in a higher order form called the functional calculus. It also includes functions, which are 'framework' expressions with one or with several variables that acquire definite truth values only when the variables are replaced by specific terms. The predicate calculus is to be distinguished from the propositional calculus, which deals with unanalyzed whole propositions related by connectives such as 'and', 'or', 'if…then', 'if and only if' and so on.

Moreover, Aristotle is considered as the logician in whose works we get the concept of predicate logic but it was Frege who developed it systematically in modern era. Now the question is 'where did Aristotle committed errors? This question needs consideration. As a matter of fact, Aristotle did not make error. That is the reason defect is not the right word to be used while assessing Aristotelian system. Instead, limitation is the apt word to be used in our analysis of Aristotelian logic. Aristotle had an

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[9] First order logic uses only variables that range over individuals (elements of the domain of discourse); where as second order logic has these variables as well as additional variables that range over sets of individuals.

idea of class at elementary level. He gave the concepts of class inclusion and class exclusion and in both these classes the inclusion-exclusion is total or partial. Aristotle could not precede further to analysis this debate. This explains the limits of his analysis of categorical proposition based on quality and quantity of proposition and the outcome of his analysis. Since at the age of Aristotle, set theory was unknown in the sense in which Cantor developed it. Therefore, let us identify the loop holes in Aristotelian system. This will help us to understand the significance of 'Quantification Logic' in particular and modern logic in general.

Aristotle didn't differentiate between universal proposition and singular proposition. A proposition is singular when the subject is a proper name. In this aspect, singular propositions differ from particular propositions, though later we understand that both are existential propositions. In his analysis these two are, more or less the same. An understanding of subtle difference and its consequences is quite illuminating. Any universal proposition of the form 'All S is P' or 'No S is P' reveals that S and P are merely class-names. If the concept of denotation is closely examined, then it becomes clear that all class-indicators include or exclude a certain number of elements known as members of a particular class, otherwise called sets. Therefore, every set represented by a term in the proposition is very much similar to denumerable set which is a set of positive integers. A set is denumerable when it is a set of positive integers because only then members are countable. If members are countable, then denotation makes sense, otherwise not. Likely, the concept of intension reveals that to be a well-defined function the member must possess a definite set of properties without which it ceases to be a member of that particular set.

Against this background, we should try to know what the difference or differences between universal and singular on the one hand and particular and singular propositions on the other signify. First let us consider universal and singular propositions. The propositions 'All Crows are Black' has both contrary and contradictory relations. However, the propositions 'Socrates is mortal' has only contradictory relation, but not contrary. It may be necessary to point out that, though it amounts to repetition, two propositions are contraries only when two conditions are satisfied; when p is true, q is false and when p is false and q is doubtful. On the other hand, contradiction arises when p is true, q is false and when p is false q is true and vice versa. Suppose that the second proposition 'Jackdaw is Black' is negated. We get 'Jackdaw is not Black'. When the first statement is true, the second statement is false. Though the first condition is satisfied, the second condition is not satisfied because when the first statement is false, the second statement is not doubtful, but turns to be true. If logical relations matter, then the distinction between universal and singular propositions also ought to matter. This is a point which Aristotle failed to notice. Further, both particular and singular are existential propositions which make matter still worse. Like universal propositions, particular propositions also have two distinct relations which distinguish them from singular propositions. Instead of contrary, sub-contrary explains one type of relation between two particular propositions. If 'Some Crows are Black' is true then 'Some Crows are not Black' is doubtful and if 'Some Crows are Black' is false, then 'Some Crows are not Black' is true. Of course, contradiction explains the relation between universal and particular. Here is the difference. Though both particular and singular propositions are existential, sub-contrary relation is not common to both. This means that universal and particular propositions, on the other hand, and particular and singular, on the other, deserve to be classified separately. They are called general propositions distinct from singular propositions because the subject of such propositions is a general term. A term which refers to an indefinite number of things is a general term which is called common noun in grammar. What we call quantifiers are applicable to general propositions but not to singular propositions.

Second difference is crucial. In this context, the emphasis is on the word existence. If a certain proposition is characterized as existential, how do we understand such characterization? When we discussed Venn diagrams in connection with the distribution of terms, we learnt that universal propositions do not carry existential import whereas particular propositions carry existential import. The statement 'All Cows are Mammals' do not affirm the existence of crows whereas ‘Some Cows are Mammals’ affirm the existence of crows irrespective of the quality of proposition. Same is the case with ‘No Cows are Mammals’ i.e. no assertion is made about the existence of crows. Existence presupposes the presence of members in a given class. If existence makes sense, then in negative sense non-existence also must make some sense. Suppose that a set does not contain a single member. Then what is its status? Till nineteenth century this question did not occur to anyone. In other words, the concept of null set paved the way for further progress in Aristotelian logic. How did it happen?

The concept of null set plays crucial role in distinguishing Aristotelian system from modern logic. Let us recall the very first statement of introduction; ‘predicate logic, is a branch of logic, which is concerned with predicates or with predication of properties, and also with things or objects to which the predicates may be ascribed’. In the strict sense of the term, predicate may be ascribed to only things or individuals actually existing. The only requirement is that the content of the argument must be factual but not fictitious.

Where does null set figure in this discussion? One fundamental relation between propositions with which we are concerned, presently, is contradiction. The law of contradiction holds well when terms include members as matter of fact. However, the situation is different when the terms represent null sets. Consider this proposition

All fruit growers of Kashmir are transporting fruits to Africa (A-Proposition)

This sentence is obvious false. Thus, according to law of contradiction, its contradiction must be true which is mentioned as

Some fruit growers of Kashmir are transporting fruits to Africa(I-Proposition)

Proposition A and I are supposed to be contradictories. The proposition I ought to be true according to the law of contradiction since the proposition A is false. But, in reality, this statement is also false. But the two contradictories cannot be false. This problem arises because we are dealing with non-existent members. Therefore, in the strict sense I-Type proposition does not carry existential import as well as Universal proposition. Within the frame work of traditional logic this problem remains unnoticed because there was no concept of set at all-whether null set or non-null set. Modern logic corrected this mistake by making null set a distinct entity. The underlying principal is that all existential propositions should include only non-null sets. This stipulation marks one difference between traditional and modern systems.

However, logical equivalence is second major factor. Let us clear it from the example

1. All triangles are plan figures
2. All equilateral triangles are equiangular triangles

We can interpret these above examples as

1a. If any figure is a triangle, then it is a plane figure

2a. A figure is equilateral triangle if and only if it is equiangular

These propositions could be symbolized as

1a=$F \rightarrow P$ or $F \supset P$

2a= $F \leftrightarrow P$. Or $F \equiv P$

Traditional logic did not distinguish these propositions. The difference between 1a and 2b becomes clear only within the framework of modern logic. This is another important progress made by modern logic over traditional logic. Such differences matter in quantification logic. This is the case of sets especially subset and proper subset. Proposition 1 discloses that the set of triangles is a proper subset of the set of plain figures. Moreover, the set of equilateral triangles is equivalent to the set of equiangular triangles. This further explains why the sentential connectives differ from 1a and 2b.

The basic difference between propositional and predicate logic lies in dealing with the internal structure of simple and compound propositions. Predicate logic includes rules hitherto used and also new set of rules. However, it is not the case with propositional logic. In real means predicate logic has its own syntax, which helps us to devise statements, which are considered well-formed statements.

Quantification and rules of quantification

As a matter of fact we always quantify quantity of propositions but not quality. We need quantifiers only to denote universal and particular. By the method of quantification which is also known as generalization, we get a general proposition. A general proposition asserts a property or properties of 'all' or some (at least one) individuals. When a proposition asserts the property of 'all' is called universal general proposition and when it asserts the properties of some. It is called an existential general proposition.

Quantification or generalization consists in asserting a propositional function of 'all' or 'some' of the values of the variable. The values of an individual variable in the propositional are individuals. If the values of the individual variable 'x' are x's or that of 'x' and y's and so on.

Quantification is of two kinds; universal quantification and existential quantification. If we assert a propositional function for all the values of the variable, we get a general proposition by universal quantification symbolized as (x) and if we assert a propositional function of some of the values of the variable we get a general proposition by existential quantification which is symbolized as (∃x).

A proposition which is obtained by universal quantification is a universal general proposition and a proposition which is obtained by existential quantification is an existential general proposition. Let us study the use of the method of quantification.

Universal quantification

A proposition function contains a variable (or variables). In the propositional function 'x is an Atomic', x is an individual variable. If this variable asserts of every 'x' we would get a proposition by universal quantification, such as

For every x, x is an atomic

This is usually stated as

Given any x, x is an atomic

It is also expressed as ‘whatever x may be’, x is an atomic. In common parlance, this proposition will be expressed as ‘everything is an atomic’. In the proposition, given any x, x is the universal quantifier (with reference to the individual variable ‘x’ the universal quantifier is also expressed by the phrase ‘whatever x may be’. In fact the phrase ‘given anything whatsoever’ or ‘whatever a thing may be’ is the universal quantifier. Here the word ‘thing’ is the individual variable.

The universal quantifier is symbolized as (x). In the quantification of a propositional function, the quantifier is placed to the left of the propositional function. **The universal quantification of the propositional function is true if and only if all of its substitution instances are true.** Thus the universal quantification of a propositional function express a conjunction of its substitution instances with reference to (x) (Ax), we may state that (x) (Ax) is true only if and only if Aa, Ab, Ac, Ad, Ae, ….is true. Here (Aa, Ab, Ac, Ad, Ae,) are singular propositions because a, b, c, d, e, are individual constants.

By universal quantifier we can obtain true as well as false propositions. The universal quantification of ‘x’ is an atomic, gives us the true proposition. ‘Given any x, x is an atomic’. This proposition is expressed as ‘everything is atomic’. On the other hand, the universal quantification of the statement ‘x is beautiful’ we get the false proposition i.e. given any x, x is beautiful which further can be expressed as ‘everything is beautiful’.

Another example is

x is a philosopher

for every x, x is a philosopher

given any x, x is a philosopher

Now if we give values to x, then the function becomes as

x is Plato, x is Aristotle, x is Hitler, x is Robinhood, x is Frege, x is Shakespeare and on

For every Plato, Plato is a philosopher is true

For every Shakespeare, Shakespeare is a philosopher is false10

Similarly, for every Frege, Frege is a Philosopher is true

And for every Hilter, Hitler is a Philosopher is false

These above examples are universal quantification of singular functions

Existential quantification and its Rules

If we assert a propositional function of some of the values of the variable contained in the propositional function, we get an existential general proposition. The process is the same as that of universal quantification except that we use an existential quantifier as '∃x'.

The propositional function 'x is sweet' is interpreted to mean 'something is sweet' or at least one thing is sweet. To get a true proposition logically, the word 'some' means the existence of at least one. Therefore, the quantifier used for expressing something is called an existential quantifier. By the method of existential quantification, we can get the following equivalent expressions.

For the propositional function 'x is sweet' we can have the following substitution instances such as

There is at least one thing that is sweet

There is at least one x such that it is sweet

There is at least one x such that x is sweet

There is at least one 'x' such that Sx.

The phrase 'there is at least one x, such that' is called an existential quantifier. By using this symbol, we can completely symbolize the existential general proposition (∃x) (Sx).

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[10] According to Aristotle everyone is philosopher that is different from contribution to philosophy and generally Shakespeare is counted as novelist not mainstream philosopher.

The existential quantifier of a propositional function is true if one of its substitution instances is true. So even of one thing is sweet, the existential quantifier is true.

The existential quantification of a propositional function is false if it's all the substitution instances are false for example, from the propositional function 'x is permanent', we get the quantifier 'at least one thing is permanent' but this proposition function is false because 'there are no permanent things'.

Rules of universal quantifier

Universal general propositions which affirms only one property of everything

Examples

'Everything is number'

This proposition may be symbolically expressed as 'x is number'

Step 1. Given anything, it is number

Step 2. (Given anything) (It is a number)

Step 3. (Given any x) (x is number)

Step 4. (given any x) (Nx)

Step 5. (x) (Nx)

So, finally the symbolic expression is (x) (Nx). This should be read as 'Given any x, x is number'. Now if we introduce predicate variable Φ (phi) in place of the predicate constant (N) then the symbolic expression (x) (Nx) can be expressed as (x) (Φx)

Universal general proposition which negates all properties of everything (denying the properties)

Example

Nothing is Permanent

Step 1. Given anything. It is not permanent

Step 2. Given anything (it is not eternal)

Step 3. (Given any x) (x is not permanent)

Step 4. (Given any x) (~ Ex)

Step 5. (x) (~ Ex)

Step 6. (x) (~ Ex)

So, finally the symbolic expression is (x) (~ Ex). This should be read as ‘Given any x, x is not permanent’. Now if we introduce predicate variable Φ (phi) in place of the predicate constant (E) then the symbolic expression (x) (~ Ex) can be expressed as (x) (~ Φx)

Existential general proposition which affirms a property of something (or at least one thing)

The proposition ‘Some Table exists’ or there is something which exists

Step 1. There is a thing such that, It exists.

Step 2. (There is a thing such that) (it is an existent)

Step 3. (There is an x, S.T) (x exists)

Step 4. (There is an x, such that) (Ex)

Step 5. (Ǝx) (Ex)

The symbolic form of this proposition can be given as

(Ǝx) (Φx)

Existential general proposition which negates a property of something (or at least one thing)

Example: Some Matter is not reality

This proposition can be expressed as ‘there is something which is not reality’ or in other words it can be represented as ‘there is at least one thing which is not reality’

Step 1. There is a thing such that, It is not reality

Step 2. (There is a thing such that) (it is a not reality)

Step 3. (There is an x, S.T) (x is not reality)

Step 4. (There is an x, such that) (~ Rx)

Step 5. (Ǝx) (~ Rx)

This should be read as ‘there is an x S.T, x is not reality’

Now if we use the predicate variable ‘Φ’ (phi) in place of predicate constant ‘R’ then the symbolic form of this proposition can be given as

$(\exists x)\ (\sim \Phi x)$

Symbolic representation

How do we symbolize the proposition ‘Aristotle is a Logician’? And ‘Plato wrote Republic’? A unique method is derived which is merely a convention. The subject term is representation by first letter of the same which is always a small letter and predicate is represented by the first letter of the same which is always a capital letter. The propositions considered above now becomes

La

Rp

The singular terms are represented in predicate in predicate logic by the individual constants. These are small letters from ‘a’ to ‘w’, with or without numerical subscripts. Their function is to denote only one, unique individual or object from the domain of discourse. Since their reference remains fixed or constant within a given context, they are called individual constants. Predicates are linguistic expressions of properties.

If we use variable x in place of constant then the statement can be represented as

Px

When variable is used in place of individual constants, we get what is known as Propositional function. It is neither true nor false. Truth values can be assigned only when constants replace the variable. Consider the following changes due to replacing variable (subject) of the statement La

1. Pa where a stands for Archimedes
2. Pb where b stands for Boole
3. Ps where s stands for Shakespeare

4. Ph where h stands for Herodotus

It is evident that 1 and 2 are true with respect to statement ‘Aristotle is a logician’ where as 3 and 4 are false. Statement 1 and 2 are true is known only when we know what a and b stand for. Therefore, in quantification logic we should find out the actual truth-status of propositions. Pa, Pb, Ps, Ph results from propositional function Px by an operation known as Instantiation. Accordingly, a, b, c etc. are called substation instances. Auxiliary, a and b are true substitution instances whereas s and h is not a true substitution instance.

We have symbolized singular propositions but there is another way to symbolize categorical proposition. Categorical propositions based on quantity and quality is of four kinds; Universal affirmative, Universal negative, Particular affirmative, Particular negative. So we can denote these four propositions with two quantifiers because quantifiers are used for universal and particular propositions (for quantity) not for affirmative and negative (quality) which are represented as follows:

A - All Glaciers are Cool ------------ $(x)\ Cx$

E - No Glaciers are Cool ------------- $(x) \sim Cx$

I - Some Glaciers are Cool -----------$(\exists x)Cx$

O - Some Glaciers are not Cool -------- $(\exists x) \sim Cx$

Thus (x) can be replaced by ‘for all ∀’. The symbols on the R.H.S need some explanation

The symbol ‘x’ is expanded in several ways. It can read as ‘for all values of x’ or ‘given any x or simply ‘for every x’, etc. where ‘x’ stands for individual constant (Glaciers) and ‘C’ stands for ‘Cool’. ~ Cx is read as ‘x is not cool’. The symbol ∃x is read ‘there exists at least one x such that…( ) is called Universal Quantifier and ∃ is called Existential Quantifier.

( ) = Universal Quantifier

∃ = called Existential Quantifier

Thus, if we substitute G (Glaciers) and C (Cool) for x then we get a propositions, which may be true or false. It may be noted that universal quantifier is true only when every substitution instance of the same is true or it has only true substitutions whereas the existential quantifiers is true when at least one substitution instance of the same is true.

Just as x is used as individual variable to denote the subject, two Greek letters Φ (Phi) and Ψ (Psi) are used to denote predicates. So they are called predicate variables. Using these variables A, E, I, O propositions can be represented as

A - All Glaciers are Cool ------------ $(x)\ \Phi x$

E - No Glaciers are Cool ------------- $(x) \sim \Phi x$

I - Some Glaciers are Cool ----------- $(\exists x)\ \Phi x$

O - Some Glaciers are not Cool -------- $(\exists x) \sim \Phi x$

Using class membership relation, categorical propositions can be written as

A - All Glaciers are Cool ------------$(x)\ \Phi x \equiv (x)\ \{ x \in \Phi \rightarrow x \in \Psi\}$

E - No Glaciers are Cool ------------$(x) \sim \Phi x \equiv (x)\ \{ x \in \Phi \rightarrow x \in \Psi\}$

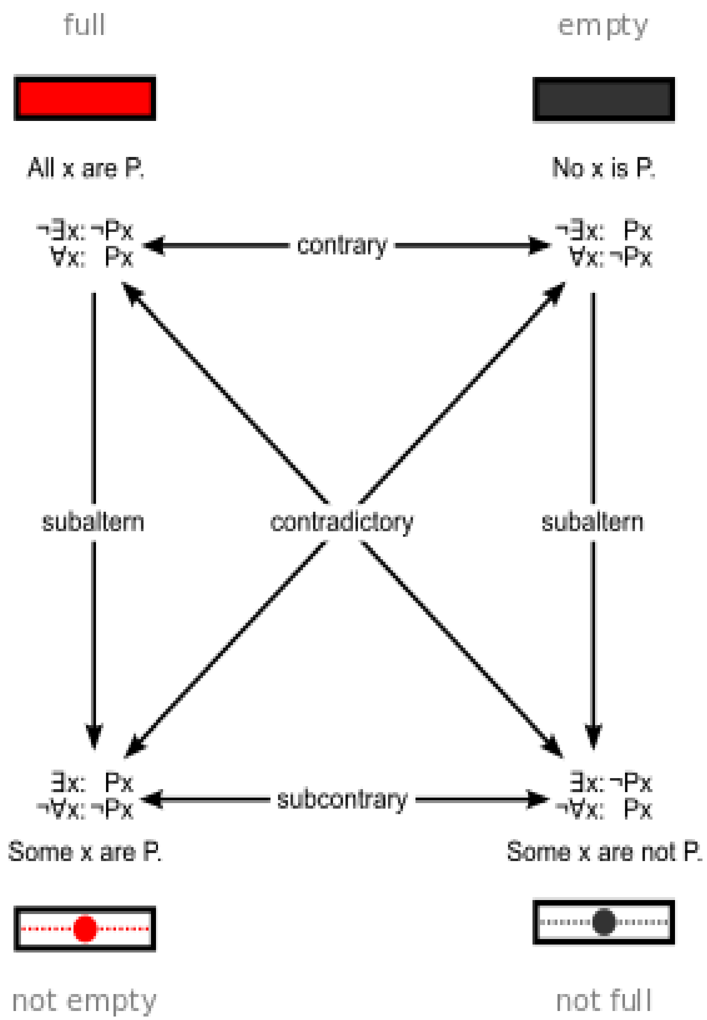
I - Some Glaciers are Cool --------$(\exists x)\ \Phi x \equiv (\exists x)\ \{ x \in \Phi \wedge x \in \Psi\}$

O - Some Glaciers are not Cool --------$(\exists x) \sim \Phi x \equiv (\exists x)\ \{ x \in \Phi \wedge x \in \Psi\}$

Where ϵ reads as (element of) and ϵ reads as (not an element of)

Quantification square of opposition

As we know that in traditional logic, propositions A, E, I O, are represented in a square in order to discuss the relation between them. Now in quantification logic we can also represent A, E, I, O in a square to determine the logical relationship of quantifiers that denote the propositions. Let’s replace A, E, I and O with these quantifiers in the square.



This is the square which represents quantifiers. Now from this square we have relations like Contrary, sub-contrary, contradiction, sub-alternation, and equivalence but we will restrict only to discuss two important relations; logical equivalence and contradiction

Equivalence can be shown as

A = $(x)\ \Phi x \equiv \{\sim (\exists x) \sim \Phi x\}$

E = $(x) \sim \Phi x \equiv \{\sim (\exists x)\ \Phi x\}$

I = $(\exists x)\ \Phi x \equiv \{\sim (x) \sim \Phi x\}$

O = $(\exists x) \sim \Phi x \equiv \{\sim (x) \sim \Phi x\}$

Contradiction can be shown as

A = $(x)\ \Phi x$ contradicts $(\exists x) \sim \Phi x$

E = $(x) \sim \Phi x$ contradicts $(\exists x)\ \Phi x$

I = $(\exists x)\ \Phi x$ contradicts $(x) \sim \Phi x$

O = $(\exists x) \sim \Phi x$ contradicts $(x)\ \Phi x$

When we use predicate variable, the propositions forms can be expressed as

A = $(x)\ \Phi x \equiv (x)\ \{\Phi x \rightarrow \Psi x\}$

E = $(x) \sim \Phi x \equiv (x)\ \{\Phi x \rightarrow \sim \Psi x\}$

I = $(\exists x)\ \Phi x \equiv (\exists x)\ \{\Phi(x) \wedge \Psi x\}$

O = $(\exists x) \sim \Phi x \equiv (\exists x)\ \{\Phi(x) \wedge \Psi x\}$

Thus if we represent A, E, I, and O with this new set, then their equivalent form also undergo changes and should be represented as

$(x)\ \{\Phi x \rightarrow \Psi x\} \equiv \sim \exists x\ \{\Phi(x) \wedge \sim \Psi x\}$

$(x)\ \{\Phi x \rightarrow \sim \Psi x\} \equiv \sim \exists x\ \{\Phi(x) \wedge \Psi x\}$

$(\exists x)\ \{\Phi(x) \wedge \Psi x\} \equiv \sim (x)\ \{\Phi x \rightarrow \sim \Psi x\}$

$(\exists x)\ \{\Phi(x) \wedge \Psi x\} \equiv \sim (x)\ \{\Phi x \rightarrow \Psi x\}$

If negation placed behind the quantifiers on the R. H. S, are removed, the automatically they become contradictories of the respective statements like as

$(x)\ \{\Phi x \rightarrow \Psi x\} \equiv \exists x\ \{\Phi(x) \wedge \sim \Psi x\}$

$(x)\ \{\Phi x \rightarrow \sim \Psi x\} \equiv \exists x\ \{\Phi(x) \wedge \Psi x\}$

$(\exists x)\ \{\Phi(x) \wedge \Psi x\} \quad \equiv \quad (x)\ \{\Phi x \rightarrow \sim\Psi x\}$

$(\exists x)\ \{\Phi(x) \wedge \Psi x\} \quad \equiv \quad (x)\ \{\Phi x \rightarrow \Psi x\}$

A predicate like Cool is called simple predicate because the propositional function which, if used, has true and false substitutions. All substitutions to variable are called 'substitution instances'. When such predicates are negated such formula or statement is called 'normal from formula'

What is the function of quantifiers? Quantifiers are expression in predicate logic which state that a certain number of the individuals or objects have the property in question. They do not state which one of the individuals have the property. A quantifier consists of

- A left parenthesis (
- A right parentheses)
- A quantifier symbol (x) or ∃
- one of the individual variable symbols

Therefore, these quantifiers are in non-natural language the symbols of quantity indicators 'all', 'some' and 'no', which may occur in statements about predications. Predicate logic uses only two kinds of quantifier symbols i.e. Universal quantifier and Existential quantifier.

Examples using Universal quantifier and Existential quantifier

1. All swans are white

   $(x)\ \{Sx \rightarrow Wx\}$

2. No Bats are Humans

   $(x)\ \{Bx \rightarrow \sim Hx\}$

3. Some Theories are Interesting

   $(\exists x)\ \{Tx \wedge Ix\}$

4. Some Philosophers are not Poets

   $(\exists x)\ \{Px \wedge \sim Wx\}$

5. Not every element is effective

   $(\exists x)\ \{Ex \wedge \sim Wx\}$

6. Descartes is a Rationalist

   $(x)\ Rd$

7. Berkeley is not a Mystic

   $(x)\ {\sim}Mb$

8. All Butterflies are Flying

   $(x)\ \{Bx \rightarrow Fx\}$

9. Some logicians are mathematicians and idealists

   $(\exists x)\ \{Lx \wedge Wx\ .\ Ix\}$

10. Some Horses are not black and domestic

    $(\exists x)\ \{Hx \wedge \sim Bx\ .\ Dx\ \}$

11. Every human being is responsible and hard worker

    $(x)\ \{Hx \rightarrow Rx.\ Hx\}$

12. No Tables are Chairs

    $(x)\ \{Tx \rightarrow \sim Cx\}$

13. Something is Poisonous and either no poison scares collum or Fiona.

    $(\exists x)(Fx\ .\ \sim (Rxa \vee Rxb))$

14. If everything is a bird, then everything attacks collum, Fiona

    $(\forall x)(Gx \supset (Txa \supset Txb))$

15. Not everything is poisonous if and only if something is poisonous and scares

    $\sim (\forall x)(Fx \equiv (\exists y)(Gy\ \&\ Rxy))$

16. If something attacks then everything attacks a person and not scares him.

    $(\exists x)(\forall y)((Gy \supset Txy)\ \&\ \sim Rxx)$

Validity and Invalidity of Arguments

We can prove the validity and invalidity of the arguments with the help of truth tables and with the help of applying rules i.e. rules of inference and rules of replacement. Now we can check the validity of the arguments by applying these rules.

a) (∀x)(Fx v Gx)

(∀x)(Fx ⊃ Gx)

:. (∀x)(Gx)

Proof:

1) (∀x)(Fx v Gx)

2) (∀x)(Fx ⊃ Gx)

3) (∀x)(Gx)

4) (∀x) (Gx v Fx) 1. Com.

5) (∀x) ~ Gx ⊃ ~ Fx 2. Trans.

6) (∀x) (Fx. Gx) 4. Com.

7) (∀x) Fx 6. Simp.

8) :. (∀x) Gx 2,7, (M.P.)

b) (∀x) (Fx ⊃ Gx)

:. ~ (G(a) ⊃ ~ F (a))

Proof:

1) (∀x) (Fx ⊃ Gx)

2) ~ (G(a) ⊃ ~ F (a))

3) F (a) ⊃ G(a) 1, UI

4) :. ~ G(a) ⊃ ~ F(a) 3, (Trans.)

c) (Ǝx) Fx

:. (Ǝx) (Fx v Gx)

Proof:

1) (Ǝx) Fx

2) (Ǝx) (Fx v Gx)

3) (Ǝx) (Fx v Gx) **1. Add.**

d) P ⊃ Q

1) R ⊃ S

2) P v R

3) :. Q v S

Poof:

1) P ⊃ Q

2) R ⊃ S

3) P v R

4) Q v S

5) (P ⊃ Q) . (R ⊃ S) 1,2, Conj.

6) :. Q v S 5,3, C.D.

CHAPTER - VII
MODAL LOGIC

Modal logic: Modal logic is the branch of logic which attempts to study model operators like possible, impossible, necessary, contingent, actuality and non-actuality. This branch of logic deals with semantics of the logical propositions where as formal logic deals with the syntatics of the logical proposition and it is necessary in model logic to assert on meaning but it is not necessary in formal logic. However, possibility is denoted by the symbol diamond (◊ or M), impossibility is denoted by the symbol (~ ◊ or ~M), necessity is denoted by the symbol box (□ or L), contingency is denoted by (~□ or ~ L), actuality is denoted by the symbol (H)11, and non-actuality is denoted by (~H).

Certain modal expressions of English language, e.g. Can, could, should, may, might, must, ought, believe, know, necessity, possibility, impossibility, actuality, contingency etc. are considered as the subject matter of modal logic. It was extensively treated by Aristotle and now in the contemporary philosophy, according to Carnap, for the first time, and C. I Lewis (1918) constructed the logic of modalities in the frame work of symbolic logic. After defining semantical concepts like logical truth etc., Carnap proposed to interpret the modalities are those properties of propositions which correspond to certain semantical properties of sentences expressing the propositions, e.g. a proposition is necessary if and only if a sentence expressing it is L-true (necessarily true).

Modal logic is a theoretical field that is important not only in philosophy but also in mathematics, linguistics, computer science and information sciences as well. Moreover, modal logic is the development of the logic of various ideas that are expressed in natural language by model words and phrases.

Modal logic is concerned with the formal validity of model propositions as well as arguments. The word valid and invalid is generally concerned with deductive arguments but this word is used by some logicians to concern logically true propositions and logically false propositions. An argument which contains at

[11] I have denoted model operator actuality with capital letter 'H', because we find symbol A which represents actuality and A resemblances with A proposition that is why I am using symbol H to denote actual modal proposition, used on natural language expression 'can'.

least one modal proposition is called a modal argument. A proposition which contains at least one modal operator is called a modal proposition. For example, the proposition

‘it is necessary that all cows are animals’

Symbol	Read as	Operation	Natural Language Example
M or ◊	Diamond	Possibility	it may be raining
N, L or □	Box	Necessity	it must be raining

Semantically, these modal connectives are interpreted with respect to possible worlds. We can conceive of possible worlds in various ways, depending on what we are interested in modeling. On the one hand possible worlds might be hypothetical, ‘alternative universe’ or the actual world, the things really are at the present moment as well as in an infinity of other worlds which differs from one another.

Now if we have a proposition p and current world w then

□p or Lp holds (p is necessary) just when p is true in all possible worlds accessible from w

◊p or Mp holds (p is possible) just when p is true in at least one world accessible from w

Now what does it mean for a world to be ‘accessible’? The clear example is surely that of a computer: an accessible state is simply a successor state one that is immediately reachable from the current state. As such, the set of all the possible worlds isn’t just an unstructured mess, when conversing about the current weather, things like Unicorns and dinosaurs are typically far from one’s mind. Rather, we are only concerned with a relevant subset of these possibilities- just those worlds which are accessible from the actual world via some implicit relation.

The English sentence below show three kinds of accessibility relation at work:

Example sentence	Modality type	Accessible Worlds
It must have Snowed overnight	Epistemic Modality	World consistent with one's knowledge
You must reach before evening	Deontic Modality	Worlds consistent with one's obligations
A triangle must have three vertices	Alethic Modality	World consistent with logic (all worlds).

These sentences might be represented as □p, □q, □r but the box operator has a noticeably different interpretation in each case.

Hence, p is impossible means non-p is necessary

p is contingent means p is neither necessary nor impossible

p is possible means p is not impossible

p is non-contingent means p is necessary or p is impossible.

Modalities with Symbols

Model property of a proposition	With 'N'	With '◊'	Semantical property of a sentence	Modal propositions
Possible (there exists)	¬ N ¬p	◊p	Non-L-false	This may be intoxicate
Impossible	N ¬ p	¬ ◊p	L-false	Apple is orange
Necessary (for all)	Np	¬ ◊ ¬ p	L-true	Zero is a whole number
Contingent	¬ Np. ¬N¬p	◊ ¬p. ◊p	Factual	Apples are sweet

Non-necessary	¬Np	◊¬p	Non-L-true	Zero is not a whole number
Non-contingent	Np v N ¬ p	¬◊¬pv ¬◊p	L-determinate	Apples are not sweet
Actuality	Hp	◊Hp	H-Existent	Pumpkin is bigger than walnuts
Non-Actuality	¬ Hp	¬◊Hp	H-non-existent	Pumpkin is not bigger than walnuts

Modal operators and their examples

Impossible things – Round Squares,

Actual things – Aristotle and Descartes

Non-actual – Unicorns, Harry potter

Possible things – Green Apples

Actuality – some horses are actual objects

Necessary –rational numbers are numbers, every event has a cause

Non-necessary – two is not a prime number.

Contingent – chalk is yellow, some cows are Hollister cows

Non-contingent – some cows are not Hollister cows, two yolked egg.

Unicorns are non-actual but possible objects

Square circles are impossible objects

Hairs horns are impossible objects

Alexander's horse is an actual object.

Modal Expressions Symbolized

◊ - It is necessary that (Alethic Logic)

□ - It is possibly that (Alethic Logic)

O -It is obligatory that (Deontic Logic)

P - It is permitted that (Deontic Logic

F - It is forbidden that (Deontic Logic)

G - It will always be the case that (Temporal Logic)

F - It will be the case that (Temporal Logic)

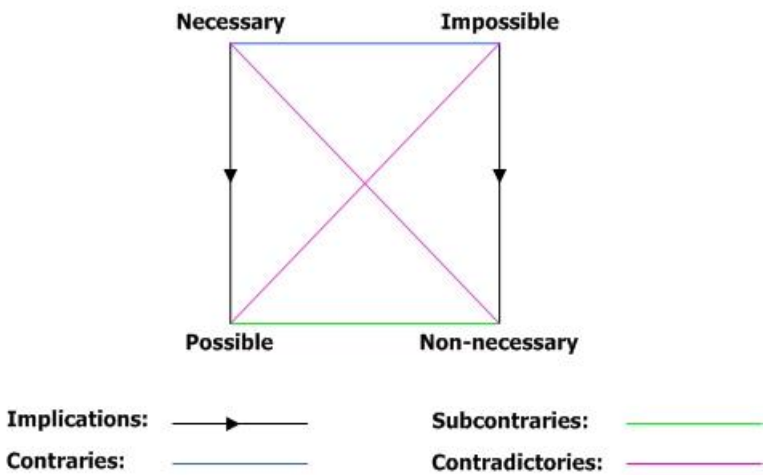
H - It has always been the case that (Temporal Logic)

P - It was the case that (Temporal Logic)

Bx - x believes that (Doxastic Logic)

Kx – x knows that (Epistemic Logic)

Model Square of Opposition of Propositions



Types of Modal Logic

There are different types of modal logic but the most important are: deontic modal logic, epistemic model logic and alethic modal logic.

Deontic modal logic

Deontic modal logic deals with the formal validity of deontic modal propositions and arguments. A modal proposition which contains at least one deontic modal operator like 'I ought to' is called deontic modal proposition. If we take the sentence that 'you must reach before evening', which is modal expression, this sentence might be uttered by airport staff to inform a passenger of the time that their flight boards. In this case the relevant worlds are those consistent with the passengers obligations, namely, to get to their airplane punctually, the box here means 'Given what is obligated, it must be the case that….'this obligation based interpretation of the modal operators is known as deontic modality.

Epistemic modal logic

Epistemic modal logic deals with the formal validity of epistemic modal propositions and arguments. A model proposition which contains at least one epistemic modal operator like 'I know that' or 'I believe that' is called epistemic modal proposition. If we take the example that 'it must have snowed overnight', which is a modal expression. From this example we can imagine that someone who upon leaving their house in the morning notices that the sidewalk is snowy. Based on this observation, they conclude that it has snowed overnight. Here, the worlds under consideration are just those which are consistent with the speaker's knowledge, in particular, their observation of the sidewalk. Thus the box means something like, 'Given what is known, it must be the case that….'. This knowledge based interpretation of the modal operators is known as epistemic modality.

Alethic modal logic

Alethic modal logic deals with the formal validity of alethic modal propositions and arguments. A model proposition which contains at least one alethic modal operator like 'it is possibly that', 'it is necessarily that', 'it is actually that' is called an alethic modal proposition. Alethic modal logic is developed by adding alethic modalities, i.e. 'it is necessarily that', it is actually that, as model operators either to truth functional propositions or first ordered quantified propositions. Thus, there are two types of alethic modal logic, namely, propositional modal logic and quantified modal logic.

Conveniently, we can view possible world semantics as an extension of truth tables. In propositional logic, we only had to fix a truth for each propositional variable once, but in model logic, each propositional variable can take a different truth value at each possible world. Even when two worlds have the same truth value assignment, formulas with □ or ◊ might have a different truth value in each world. Since the worlds accessible from each may not be the same. Thus, we might say that each possible world has its own truth tables. A complete assignment of truth values to each variable at each world is known as a valuation.

The word 'alethic' is originated from the Greek word 'aletheia', that means 'truth'. The word 'alethic' in the expression 'alethic modalities' is used in the sense of 'having' to do with truth. Accordingly, when alethic, 'it is necessarily that', 'it is possibly that', 'it is not possible', 'it is actually that' are added to truth functional propositions or first ordered quantified propositions as model operators to express different modes of their truth. The notions 'necessity', possibility and actuality, are used as model operators in logical sense. Some true propositions e.g. All yellow things are colored, there is no square circle, all carrots are vegetables, All igneous rocks are rocks, are necessarily true. A proposition is necessarily true if and only if it could not be otherwise, i.e., its negation is a contradiction. The proposition which is L-true is true in all possible worlds. When we say that a proposition is necessarily true in the logical sense, truth is ascribed to it in an unconditional sense or we ascribe an absolute mode of truth to that proposition. On the other hand, some true propositions e.g., chilies are red, apples are sweet, the earth is round, etc. are possibly true. A proposition is possibly true if and only if it could be otherwise, or we can say that it is true in at least one of the possible worlds.

Alethic modalities are used as monadic operators to form modal propositions. For example, if a proposition 'p' is necessarily true, we may express it as 'Necessarily p' (L) and if a proposition p is possibly true, we may express it as 'Possibly p' (M), if a proposition p is actually true, we may express it as 'actually p' (H). Modal operators 'Necessarily □' and 'possibly ◊' are inter-definable. That means, any one of them may be definable in terms of other:

- **Necessarily P (□P) = Not possible that not P (~◊~P)**
- **Possibly P (◊P) = Not necessarily not P (~□~P)**

R. Carnap describes modal logic as the theory of modalities, namely; necessity, contingency, possibility, impossibility, etc., but in this work I have explored one more modal operator 'actuality'. He thinks that to clarify each modal concept, we have to correlate each modal concept with a corresponding semantical concept. For example, the modal concept necessity is correlated with L-true.

A sentence is L-True means that it is necessarily in Leibnitz's sense and analytical in Kant's sense. A sentence Si is L-true in a semantic system Si if and only if Si is true in Si in such a way that its truth can be established on the basis of the semantical rules of the system Si alone, without any reference to extra linguistic facts. The definition of L-true is as follows:

A sentence Si is L-true in S1 = Si holds in every state description12 (in Si).

[12] In response to state description, Carnap writes 'it gives a complete description of a possible state of the universe of the individuals with respect to all the properties and relations expressed by predicates of the system. Thus the state descriptions represent Leibnitz's possible worlds or Wittgenstein's possible state of affairs.

CHAPTER - VIII

CRITICAL THINKING

Critical thinking

All kinds of thinking are not critical and only that part of thinking is critical which is either logical or clear. However, some kind of thinking could be fallacies, imaginary and mysterious. Now we can easily differentiate between thinking and thought. While thought presupposes thinking. It means that though is the component of thinking which is either true or false and must satisfy the criteria of factuality, logical rules and validity and then it will take the form of critical thinking. Critical Thinking is the process of using reasoning to discern what is true, and what is false, what is valid and invalid. Critical thinking deals with correct reasoning and makes us aware about the false reasoning. It differentiates facts from opinions as it is always concerned with those problems of the universe that are factual and argumentative. In critical thinking we don't dismiss anything without careful logical investigation and examination and we are not recognizing anything without logical examination. In logical enquiry we are asking questions about oneself and to others because on the bases of these questions we can conclude on the assertion of premises. We resist ourselves not to commit any kind of fallacy during critical thinking. Critical thinking is a process which can be about anything in the world but only the thing or problem can be factual and empirical. Critical thinking does not include any mysterious. Critical thinkers question everything; using their tools to find out the truth, wherever it may hide. The tools they use are logic, inductive reasoning, deductive reasoning research, and experience. Critical thinking can not only make you manipulation proof, it can open new vistas for you, as things previously hidden become clear.

Critical thinking is a general term that covers all logical thinking processes that strive to get below the surface of something: questioning, probing, analyzing, testing and exploring. Critical thinking requires detective-like skills of persistence to examine and re-examine an argument, in order to take in all the angles and weigh up evidence on every side. To think critically is never to take something on 'face value' but to question and think independently about an issue, however 'authoritative' a writer or thinker may be. To evaluate, or ‘critically’ evaluate is to reach a conclusion, through a process of critical thinking, about the value, or ‘soundness’ of an academic argument. Critical analysis is a key activity in evaluation. Evaluation is about weighing up the strengths and weaknesses of an argument in order to decide how much it contributes to a particular body of knowledge in your subject.

“Critical,” after all, is derived from the Greek word *krisis,* which means “to separate”. When life presents us with turning points, when we are faced with situations that require decisive action, when we need plans that will yield positive consequences, then we also need critical thinking. Such thinking allows us to separate ourselves from the crisis that can suck us into disaster and permits us, instead, to forge new pathways to success.

Thinking may be of many kinds but in this work we are concerned only with critical thinking. Critical thinking considers three orders; first order thinking, second order and higher order thinking. However, we are known of the fact that critical thinking is a skill to solve our problems, problems of the world and make us understand about decisions and a decision making.

First order thinking is the process of considering the intended and perhaps obvious inference of a business decision, plans, motivation, social issues, world problems, management, education policies and policy change. First order thinking example is that ‘these toads will kill the pests we hate’. First-level thinking is simplistic and superficial and just about everyone can do it. Second-level thinking is deep, complex and complicated. The second-level thinker takes a great many things into account:

Second order thinking is the process of sketching and separating the inference of those first order contacts. Second Order Thinking is a critical practice for making effective policy, decision making, knowing the structure of the problem, business and personal decisions, helps us in understanding the social issues, management, life, environment, existence, plans, and other phenomenon’s related to our day to day life. Many of our self-created problems as a society are due to people’s lack of second order thinking. Second order thinking example is that 'these toads are poisonous and have no natural predators here. Soon they will be the pests. The entire debate around global warming is so difficult because global warming is a second order effect. It's gloomy, hard to understand and complex—but the impact on people's lives is very real.

Critical thinking is the ability to engage in reflective and independent thinking, and being able to think clearly and rationally. Critical thinking does not mean being argumentative or being critical of others. Although critical thinking skills can be used in exposing fallacies and bad reasoning, they can also be used to support other viewpoints, and to cooperate with others in solving problems and acquiring knowledge. Critical thinking is a general thinking skill that is useful for all sorts of careers and professions. Clear and systematic thinking can improve the comprehension and expression of ideas, so good critical thinking can also enhance language and presentation skills. It is sometimes suggested that critical thinking is incompatible with creativity. This is a misconception, as creativity is not just a matter of coming up with new ideas. A creative person is someone who can generate new ideas that are useful and relevant to the task at hand. Critical thinking plays a crucial role in evaluating the usefulness of new ideas, selecting the best ones and modifying them if necessary. Critical thinking is also necessary for self-reflection. In order to live a meaningful life and to structure our lives accordingly, we need to justify and reflect on our values and decisions. Critical thinking provides the tools for this process of self-evaluation. This mini guide contains a brief discussion of the basics of critical thinking. It is neither a comprehensive survey nor a self-contained textbook. The aim is to highlight some of the more important concepts and principles of critical thinking to give a general impression of the field.

Purpose of Critical Thinking

- distinguish between rational claims and emotional ones
- Separate fact from opinion

- recognize the ways in which evidence might be limited or compromised
- Spot deception and holes in the arguments of others
- present his/her own analysis of the data or information
- recognize logical flaws in arguments
- draw connections between discrete sources of data and information
- attend to contradictory, inadequate, or ambiguous information
- Construct cogent arguments rooted in data rather than opinion
- select the strongest set of supporting data
- avoid overstated conclusions
- identify holes in the evidence and suggest additional information to collect
- recognize that a problem may have no clear answer or single solution
- propose other options and weigh them in the decision
- consider all stakeholders or affected parties in suggesting a course of action
- articulate the argument and the context for that argument
- correctly and precisely use evidence to defend the argument
- logically and cohesively organize the argument
- avoid extraneous elements in an argument's development
- Present evidence in an order that contributes to a persuasive argument

Principle of Critical Thinking

As human beings, we are not doomed to reach conclusions and make decisions like the ones in these examples. Our primary tool in making better judgments is critical thinking. Critical thinking is the careful application of reason in the determination of whether a claim is true. Notice that it isn't so much come up with claims, true or otherwise, that constitutes critical thinking; it's the evaluation of claims, however we come up with them. You might say that our subject is really thinking about thinking—we engage in it when we consider whether our ideas really make good sense. Of course, since our actions usually depend on what thoughts or ideas we've accepted, whether we do the intelligent thing also depends on how well we consider those thoughts and ideas. Why do reason, logic, and truth seem to play a diminished role in the way India now makes important decisions? —The same principles that apply to your everyday decisions (Whose critical thinking class should I take, Chomksy's or Fodor's?) also apply to issues of worldwide importance (Should the China invade India? Is global warming a serious threat?). In matters both big and small, the more critical thinking that goes on, the better. According to Paul and Elder (2007), "Much of our thinking, left to itself, is biased, distorted, partial, uninformed or down-right prejudiced. Yet the quality of our life and that of which we produce, make, or build depends precisely on the quality of our thought." Critical thinking is therefore the foundation of a strong education. Using Bloom's Taxonomy of Thinking Skills, the goal is to move students:

From lower- to higher-order thinking

From knowledge (information gathering)

To comprehension (confirming)

To application (making use of knowledge)

To analysis (taking information apart)

To evaluation (judging the outcome)

To synthesis (putting information together) and creative generation

Thus, providing students with the skills and motivation to become innovative producers of goods, services, and ideas. This does not have to be a linear process, but can move back and forth, and skip steps.

Questions of Critical Thinking

How to think and what to think?

How to think validly?

What type of procedure do we employ during critical thinking

How to use critical thinking for decision procedures

Which outcome do I think will occur?

Critical thinking and Philosophy

The question I wish to raise is: Just what is the relationship of critical thinking to philosophy? On the one hand, it can readily be acknowledged that critical thinking is what philosophers do, and that teaching critical thinking can be construed, at least in part, to be teaching philosophy. On the other hand, does teaching critical thinking alone suffice to introduce students to philosophy? Is critical thinking a necessary or a sufficient condition for philosophy? Philosophers have been successful in introducing critical thinking or informal logic courses into the curriculum and in having they considered as philosophy courses. Is philosophy merely or mainly a methodology or does it have subject matter that is unique to it as a field of study? And who is to answer these questions. It isn't only or principally philosophy which has been so in Critical Thinking and Philosophy influenced by such factors. Far too many college courses in English literature have been reduced to little more than composition classes. Such courses are seen as serving the development of reading and writing skills while the value of the literary heritage is diminished. Just as the study of English literature is being reduced to proficiency in grammar and syntax, is the study of philosophy to be reduced to proficiency in the identification of fallacies and the evaluation of arguments? Are we to have an enrollment-driven definition of the basic humanities disciplines? To return to the question posed at the beginning of these remarks: is critical thinking philosophy? Is philosophy to be equated with critical thinking to the point that a single course in critical thinking may be construed as having properly introduced a student to philosophy? I maintain that, while courses in critical thinking are philosophy they should not be used as substitutes for introductory philosophy courses. Critical thinking courses are to be considered as philosophy courses because they introduce students to, and aim to develop in them, the intellectual processes typically characteristic of philosophical discourse and reflection. They take as subject matter, if only in passing, questions of an epistemological nature which are well within the province of philosophy. Still, most critical thinking courses make no effort to introduce the scope of the philosophical tradition or the various branches or areas of philosophy, or the most significant traditions within the philosophic heritage. So they ought not be considered appropriate vehicles for introducing students to philosophy. Consequently, where there is a requirement in philosophy that was founded upon a desire to introduce students to the philosophical traditions and heritage, courses in critical thinking ought not be used to satisfy that requirement, or else they should be modified to include material which is now absent from them. It ought to introduce students to those ideas which have marked the tradition as unique for millennia: truth, knowledge, and validation, yes: but also beauty, goodness, the nature of being, the existence and nature of a god, the meaning of a human life, the nature and value of art, religion and science, and even the nature and value of philosophy. The third and final point is that learning critical thinking is not something which people had heretofore done by taking a specific course. In fact it would probably not be inaccurate to claim that those teaching such courses today did not themselves ever take one. Philosophers have learned to be critical thinkers in good measure through the study of the works of philosophers and through discourse with philosophers. It is in the study of the philosophical heritage that one sees evidence of critical thinking, indeed some of the finest examples of critical thinking the human species has produced. The study of that tradition through the works themselves has served well to instruct others to become critical thinkers. Teaching the works of that tradition, with attention to the development of the intellectual skills, methods, and stratagem which produced them, would not be such a bad way to teach critical thinking today and it might serve students in more ways than most critical thinking courses do at present.

Identification and Analysis of the Problem

Analytical thinking involves particular processes, in particular breaking down the 'parts' and looking at them more closely. (Think back to the second-hand car) It involves:

- Standing back from the information given and examining it carefully from different angles
- Checking the accuracy of statements
- Checking the logic – whether points follow each other logically
- Spotting flaws or 'jumps' in the reasoning
- Identifying 'gaps' – arguments or information that might be relevant but has been left out
- Checking for persuasive techniques, which encourage you to agree of attempts to persuade that are arguments, not all are good arguments. So when analyzing attempts to persuade we have to perform three tasks:
- The crucial first stage involves distinguishing whether an argument is being presented. We need to identify the issue being discussed, and determine whether or not the writer or speaker is attempting to persuade by means of argument.
- Once we have established that the writer/speaker is presenting an argument, we can move to the task of reconstructing the argument so as to express it clearly, and so as to demonstrate clearly the steps and form of the argument's reasoning.
- A clear reconstruction makes our third and final stage – evaluating the argument, asking what's good about it and what's bad about it – much easier to perform and to justify.

Identifying inconsistencies

First, I will define consistency; a set of statements is logically consistent if they can all be true at the same time. A set of statements is logically inconsistent if they cannot all be true at the same time or two (or more) statements are inconsistent with each other when it is logically impossible for all of them to be true at the same time. For example, “The earth is flat”, and “The earth is spherical” are inconsistent statements since nothing can be both flat and spherical, on the other hand, if you have any two statements that are both true, they are certainly consistent. Inconsistent statements are contradictory statements i.e. if ‘All Swans are White’ is true then ‘Some Swans are not white’ is false.

In logic we are dealing with arguments and propositions and it is subject matter of logic to identify inconsistencies with regard to argument and propositions. We should also evaluate set of beliefs, opinions and also decisions in order to know the relationship between them is consistent or inconsistent.

Two claims are consistent when both can be true at the same time. For example, the claim ‘lying is sometimes acceptable’ is consistent with the claim ‘lying is sometimes unacceptable’. This is because both claims could be correct. Two claims are inconsistent when both cannot be true at the same. They can, and this is important to note, both be false at the same time. For example, the claim ‘Kashmiries are Vegetarians’ is inconsistent with the claim ‘Kashmiries are not Vegetarians’, this is because while these claims cannot be true at the same time, but they could both be false. While we sometimes use ‘inconsistent’ and ‘contradictory’ interchangeably, they do not mean the same thing. If two claims contradict each other, then one of them is true and other false, for example, if ‘God exists’ is true then ‘God does not exists’ is false.

If we have multiple claims or beliefs which is inconsistent then at least one statement must be false and in relation to consistency, at least one claim must be true. Thus law of inconsistency holds that all claims cannot be true, at least one must be false.

Soundness

Given a valid argument, all we know is that if the premises are true, so is the conclusion. But validity does not tell us whether the premises or the conclusion are true or not. If an argument is valid, and all the premises are true, then it is called a Sound argument. Of course, it follows from such a definition that a sound argument must also have a true conclusion. In discussion, it would be nice if we can provide sound arguments to support an opinion. This means showing that our argument is valid, and that the premises are all true. Anyone who disagree would have to show that our premises are not all true, or the argument is not valid, or both. This method of carrying out a rational discussion is something we should follow if we want to improve our critical thinking

Seven stages of scientific Investigation

We may identify and analyze the problem into seven stages which are patterns and systematic approaches to scientific and logical problems. Every problem in science as well as in logic shall possess these five stages.

(i). Identifying and analysis of the problem

The identification of the problem considers not only problems and challenges but also constraints on opportunities that are preventing the goals and objectives from being achieved. Identification should be based on empirical observation, such as data and information obtained from surveys, interviews, and studies from a wide range of sources. Scientific investigation begins with a problem of some kind. By 'problem' we mean some fact or group of facts for which we have no acceptable explanation: the medical investigator confronts a puzzling disease or disorder; the detective is charged with the duty of solving some reported crime. The problem may, in some cases, be sharply identified: if the earth is a sphere, how it is located? How heavy is it?, How many moons do earth have? how it is free in space? Or the problem (as in the great Sherlock Holmes stories of Arthur Conan Doyle) may arise from some puzzling event or circumstances in need of explanation. The peculiarities or inconsistencies that evolve into specifiable problems may be discovered only gradually. But no one not even Galileo Galilei, Isaac Newton, Descartes, Einstein and Darwin can engage in productive scientific inquiry unless there is something, sharply defined or vaguely troubling, to think about. Reflective thinking, whether the investigation be in medicine, or mathematics, or law-enforcement, in Artificial intelligence, Data sciences, is problem-solving activity, as John Dewey and other modern philosophers have rightly insisted. The first step in any scientific investigation is that of recognizing some problem to be addressed.

(ii). Devising Preliminary Hypotheses

Even the most tentative consideration of alternative explanation of the problem at hand requires some preliminary theorizing. The first attempt is not likely to yield a final solution, but some theorizing is required in order to know what sort of evidence needs to be collected, and where or how it might best be sought. The detective examines the scene of the crime, interviews suspects, and seeks clues-but bare facts are not clues. Clues become meaningful only if they can be fitted into some pattern that is coherent, even one that s rough and tentative.

So too the scientist begins the collection of evidence with some preliminary hypothesis about the nature of the explanation sought. Some previous knowledge must be relied upon; science does not begin from absolutely nothing. Indeed there must have been some prior beliefs if the facts to be explained appear genuinely problematic.

For any serious problem, there are too many relevant facts, too much data in the world for anyone to collect it all. Some matters will be noticed and attended to, others not. The most patient and thorough investigator must choose, from among all the facts revealed, which are to be studied and which are to be to set aside. This requires some working hypothesis for which, or in the light of which, relevant data may be collected. That hypothesis need not be a complete theory- but at least the outline of a theory must be there. If it were not, the investigator could not determine which facts, from the totality of facts, to select.

However incomplete and tentative, preliminary hypothesis is needed before any serious inquiry can begin.

(iii). Collecting and organizing the data or facts and identifies the errors

The fact or facts that initially seemed puzzling are generally too manager to suggest a wholly satisfactory explanation for them; if that were not the case, those facts are unlikely to have appeared problematic. But, especially to a scientist who is familiar with facts or circumstances of that general kind (say celestial, or sociological, or historical phenomenon), the original problem will suggest a preliminary hypothesis that can guide the search for additional relevant facts. This additional evidence may serve as leads, suggestions pointing to a fuller and more nearly adequate solution. This task of collecting evidence is arduous and time consuming; very frequently it is disappointing and frustrating. Good science is hard work. This laborious of collection is the substance of much scientific work.

Of course, step 2 and 3 are not fully separable in real-life science; they are intimately connected and interdependent. Some preliminary hypothesis is needed to begin the collection of evidence; thus the process of gathering evidence by using that working hypothesis merges with the process of adjusting and refining the hypothesis itself, which then guides the further search leading perhaps to new findings which further suggests yet more refined hypothesis and so on and so on.

(iv). Formulating the explanatory hypothesis

In any successful investigation, that point sooner or later will be reached at which the investigator; the scientist, the detective, perhaps some ordinary person will come to believe that all the facts needed for solving the original problem are in hand. The pieces of the puzzle more like the chunks, each consisting of small pieces is before him or her, and the task becomes that of assembling them in such a way as to make sense of the whole. The end product of such thinking, if it is successful, in some hypothesis that accounts for all the data, the original set of facts that created the problem, as well as the additional facts to which the preliminary hypothesis pointed.

There is no mechanical way of arriving at some overarching theory. The actual discovery, or inventing, of a truly explanatory hypothesis is a process of creation, one in which imagination as well as knowledge is involved. Some investigators such as Sherlock Holmes and Albert Einstein show genius in this process of 'reasoning backward' to the explanation of existing phenomena. But every successful scientist must undertake this challenging task of intellectual integration: constructing and formulating the final hypothesis that explains the problematic facts by which the investigation was provoked.

(v). Reducing Further Consequences

A really fruitful hypothesis will explain not only the facts that provoked the inquiry, but many other facts as well. A good hypothesis may point beyond the initial problem to new facts, and perhaps even some facts whose very existence may not have been previously suspected. The verification of these facts confirms (but, of course, does not prove with certainty) the hypothesis that led to them. For example, the cosmological theory known as "The Big Bang theory" hypothesis that the present universe began with one extraordinary explosive event, the initial fireball would have been smooth and homogenous, lacking all structure. But the universe today has a great deal of structure, is 'lumpy', its visible matter clumped into galaxies, clusters of galaxies and so forth. When and how did this structure arise? If it were possible to look back in time, the seeds of present structure must be identifiable if the Big Bang theory is correct. If early structure is not detectable then this theory is doubtful, however, if early structure as defined in this theory is detectable then the Big Bang theory is confirmed, though of course not proved.

(vi). Testing the consequences

The apparent rotation of Foucault's Pendulum has been tested and showed on innumerable occasions. Modern versions of the pendulum show clearly that the apparent rotation of the pendulum in the northern hemisphere is clockwise; tests of the other predictions to which the theory leads have resulted in repeated confirmation, of course. That the length of the rotation at the South Pole would be exactly 24 hours was a prediction confirmed in experience at the Pole in the year 2001.

In a biological context we may formulate the hypothesis that a particular protein is produced in mammals as a reaction to a particular enzyme, and that enzyme is produced under the direction of a specifically identified gene. From that hypothesis we may deduce the further consequence that where that gene is absent, there will be an absence, or a deficiency, of the protein in question.

To test whether that biological hypothesis is correct, we construct an experiment in which the impact of that identified gene may be measured. Often this can be done by breeding mice in which that critical gene has been deleted-what are called "knockout mice." If in such mice the enzyme in question, and the protein associated with it, are indeed also absent, our hypothesis will be confirmed, much very valuable information in medicine is acquired in just this way. Experiments of this general kind are typical of those conducted in a wide range of biological inquiries. We devise the experiment to determine whether what we had thought would be true (if such-and such were the case) really is true. And to do that we must often construct the very special circumstances in which such-and-such has been made the case. "An experiment," as the great physicist Max Planck said, "is a question that science poses to Nature, and a measurement is the recording of Nature's answer."

Testing the consequences of predictions like many of those of Sherlock Holmes may be straightforward. Will the bank robbers break into the vault? Holmes and Watson wait for them and they do. Will the doctor slip a venomous snake through the dummy ventilators? Holmes and Watson watch from hiding, and he does. Those explanatory theories were directly tested and solidly confirmed.

Most scientific theories, of course, cannot be tested by simple observation. The structure of the early universe cannot possibly be observed directly. But if there were some early structures, like that predicted by the Big Bang theory, there would have to be irregularity, unevenness in the background radiation currently encountered that stems from that early time. It is possible, in principle, to measure that background microwave radiation, and in this way to determine, indirectly, whether there were such irregularities very shortly after the supposed Big Bang. The Cosmic Background Explorer (COBE) satellite, designed to detect those predicted radiation irregularities, did indeed detect and measure them in the spring of 1992. Although this test did not prove the theory correct, it did confirm the Big Bang theory impressively.

In his general theory of relativity, propounded in 1916, Albert Einstein hypothesized that massive bodies cause space-time to curve. Gravity (Einstein's theory explained), which appears as an attraction between massive objects, is in fact a manifestation of that curvature of space-time. But how is this to be tested? It was long ago deduced from the general theory of relatively that space-time would be twisted in the vicinity of a rotating body. So an indirect test of the general theory was proposed in the 1950s. A satellite carrying an extremely stable gyroscope would be sent into an orbit that crosses the poles of our planet. If the rotation of the earth were indeed twisting space-time, the gyroscope's axis of rotation would tilt slightly, due to what is called the earths 'frame-dragging'.

(vii). Applying the Theory

Through science we aim to explain the phenomenon we encounter, but we aim also to control those phenomena to our advantage. The abstract theories of Copernicus, Galileo, Newton and Einstein have played a central role in the modern exploration of our solar system. But suppose, take an example of a very different kind, that the problem confronted in some disease, and the explanatory hypothesis devised is that the disease is caused by certain specified bacteria. Suppose that this theory has been tested by infecting mice or other rodents with those bacteria, and that such tests strongly confirm the explanatory hypothesis by producing, in the animal subjects, the very same disease. We will seek to apply that theory in clinical medicine, of course, and that would be done (first in experimental human groups, later as a matter of routine medical care) by eliminating those bacteria from patients suffering from that disease, thereby curing the disease itself. In just this way we have learned how to combat, and in some cases eve to eliminate entirely, many terrible human diseases. We seek to understand our world through science, but through science we want also to exert some measure of control over the hazards the world presents.

Identification of Errors in Research

Here are five common errors in the research process:

1. Population Specification

This type of error occurs when the researcher selects an inappropriate population or universe from which to obtain data.

2. Sampling

Sampling error occurs when a probability sampling method is used to select a sample, but the resulting sample is not representative of the population concern. Unfortunately, some element of sampling error is unavoidable. This is accounted for in confidence intervals, assuming a probability sampling method is used.

3. Selection

Selection error is the sampling error for a sample selected by a non-probability method.

4. Non-responsive

Non-response error can exist when an obtained sample differs from the original selected sample.

5. Measurement

Measurement error is generated by the measurement process itself, and represents the difference between the information generated and the information wanted by the researcher.

Evaluating the Argument

An argument is a set of propositions in which premises support the conclusion. In an argument we infer conclusion from the premise. We know that argument is either valid or invalid and consequently logic deals with arguments. Argument is made up of premises and conclusion where premise is a statements or propositions used in an argument to support from other proposition and conclusion is a proposition in an argument that the other propositions i.e. premises support it. As logicians use the concept an argument which consist any group of propositions of which one is claimed to follow from the others, which are regarded as providing supporter or grounds for the truth of that one. An argument must have a structure. The conclusion of an argument is the proposition that is affirmed on the basis of the other propositions of the argument. Those other propositions which are affirmed or negated as providing support for the conclusion, these are the premises of the argument. The simplest kind of argument consists of one premise and a conclusion that is claimed to follow from it. Each may be stated in a separate sentence like

Scientific theories are improvable – **Premise**

Theory of Relativity is a scientific theory – **Premise**

Therefore, theory of relativity is improvable – **Conclusion**

Most of the arguments are complicated, made of compound propositions with their several components related intricately. But every argument, whether simple or compound consists of group of propositions of which one is the conclusion and the others are the premises offered to support it.

Consider the hypothetical proposition

If is likely that life evolved on countless other planets that scientists now believe exist in our galaxy, because life very probably evolved on mars during an early period in its history when it had an atmosphere and climate similar to earth's.

In the above argument; 'life very probably evolved on Mars during an early period in its history'- premise

'life likely evolved on countless other planets – **premise followed from above premise**

Thus hypothetical proposition may look like an argument but it can never be an argument, and the two should not be confused.

Consequently, every argument is a structured cluster of propositions, not every structured cluster of propositions is an argument.

Kinds of arguments

Arguments are of two kinds; inductive argument and deductive argument

Inductive argument

In inductive argument, premise asserted more than what is inferred in conclusion. That is why inductive argument is based on probability and observation. Inductive argument claims to support its conclusion only with some degree of probability.

In an inductive argument no claim of conclusiveness is made. Even if the premises of an inductive argument are true, they do not support its conclusion with certainty. Inductive arguments therefore make the weaker claim that their premises support their conclusions with probability. The terms validity and invalidity do not apply to inductive arguments. We can evaluate such arguments, of course, and the appraisal of inductive arguments is a leading task of scientists in every sphere. The higher the level of probability conferred on its conclusion by the premises of an inductive argument, the greater the merit of that argument. We may say that inductive argument may be better or worse and weaker or stronger and so on. But even when the premises are all true and provide very strong support for the conclusion, that conclusion is not established with certainty.

For example

Crows in Kashmir are black

Crows in India are black

Crows in Asia are black

Therefore, All crows are black

Example

Theory of relativity is improvable

Newton's gravitational theory is improvable

Schrödinger's theory is improvable

Copernicus theory of cosmos is improvable

Big Bang theory is improvable

Therefore, All scientific theories are improvable.

Deductive argument

Deductive arguments are evaluated on the basis of validity and invalidity. A deductive argument makes the claim that its conclusion is supported by its premises conclusively. When the claim is made that the premises of an argument (if true) provide incontrovertible grounds for the truth of its conclusion. That claim will be either correct or incorrect. If it is correct, that argument is valid. If it is not correct i.e. the premises when fail to establish the conclusion irrefutably although claiming to do so, then that argument is invalid.

For logicians the term validity is applicable only to deductive arguments. To say that a deductive argument is valid is to say that it is not possible for its conclusion to be false if its premises are true. Thus we define validity as follows: **A deductive argument is valid when, if its premises are true, its conclusion must be true**. In everyday speech, of course, the term valid is used much more loosely.

Although every deductive argument makes the claim that its premises guarantee the truth of its conclusion, not all deductive arguments live up to that claim, of course. A deductive argument that fails to do so is invalid.

Since every deductive argument either succeeds or does not succeed in achieving its objectives, every deductive argument is either valid or invalid. This point is important: If a deductive argument is not valid, it must be invalid; if it is not valid, it must be valid.

The central task of deductive logic is to discriminate valid argument from invalid ones. Over centuries logicians have devised powerful techniques to do this-but the traditional techniques for determining validity differ from those used by most modern logicians. If a deductive argument is valid, no additional premises could possibly add to the strength of that argument. For example, if all roses are red and Marigold is a rose, we may conclude without reservation that Marigold is red- and that conclusion will follow from those premises no matter what else may be true in the world, and no matter what other information may be discovered on added. If we come to learn that Marigold is flower, or that rose is fragrant, or that roses are best for extracting oil, none of those findings nor any other findings can have any impact on the validity of the original argument. The conclusion that follows with certainty from the premises of a deductive argument follows from any enlarged set of premises with the same certainty, regardless of the nature of the premises added. If an argument is valid, nothing in the world can make it more valid; if a conclusion is validly inferred from some set of premises, nothing can be added to that set to make that conclusion follow more strictly, or more validly.

Example

All bachelors are unmarried

X is a bachelor

Therefore, x is unmarried

Valid argument

Validity is one of the attributes of argument. In a valid argument, if all the premises are true, the conclusion must be true and this validity belongs only to deductive arguments. **A deductive argument is valid when the premises and the conclusion are as related as it is impossible for the premises to be true unless the conclusion is true also.** Now in case of valid argument form; an argument form is valid when it has no substitution instances with true premises and a false conclusion

Invalid argument

Invalidity is one of the attributes of argument. In an invalid argument, the conclusion is not necessary true, even if all the premises are true; applies only to deductive arguments. Now in case of invalid argument form; an argument form that has at least one substitution instances with true premises and false conclusion.

Three criteria used to evaluate arguments

When we evaluate anything, we judge its quality. We say it is good or bad. Argument quality can be judged as good or bad from three different perspectives. While these perspectives can overlap in a final analysis of a given argument's quality, each can be considered independently. Because the purpose of arguments is often to persuade others of the truth of the point we are arguing, we often evaluate an argument as good or bad based on whether or not it is persuasive. Persuasiveness concerns whether or not an argument actually persuades someone that the conclusion is true. This issue is subjective and psychologically driven. Consider, the example of a lawyer arguing the innocence of her client. In the final analysis, the client will be happy, if the lawyer persuades the jury in her favor. How the arguments are structured or even if they contain true statements will be less important. What will matter most is whether the lawyer successfully persuades the jury that her client is not guilty. If she is successful, it is likely her arguments will be judged as good; if she fails the opposite. Persuasive arguments need not be logically correct. In fact, humans can be quite easily persuaded by fallacious arguments. Arguments can incorporate flaws that rely on psychological or language tricks play on the fact that we often do not think too deeply about what we hear or even think. Logical fallacies are studied in as a part of informal logic. Many are given names, such as false cause reasoning, argument ad hominem, appeal to pity, slippery slope, red herring, hasty generalizations, and strawman arguments. There are dozens of such flaws and a good reasoned should be aware of them. Arguments can also be flawed because they contain false statements. When we consider the truth or falsity of statements in an argument, we are evaluating it from the perspective of content. From this perspective we want to know whether or not the statements in the argument are actually true or false. We may be unaware that the statements are false, or we may believe they are in fact true. While truth value will play a role in the evaluation of arguments, from a strictly logical perspective logicians have no unique way of knowing whether any given statement is true or false. This requires knowledge of the subject matter or experience with the issue being argued about. If we lack this knowledge or experience, we can research the facts from reliable sources or appeal to the knowledge of experts, relying on a trustworthy, authority. Sometimes it is best to simply defer judgment on the matter of content because we have no special expertise. Rather than being a sign of weakness and ignorance, deferring judgment on matters we do not know anything about is strength in critical thinking. Formal logic deals with truth value possibilities and has developed truth tables to address the need to consider the truth value possibilities of statements in arguments, but it does not take up the question of whether a given statements is actually, factually true or false. Finally, we can judge the structure or form of an argument. In deductive logic, structure is the most important aspect of an argument and the deciding feature of its quality. Here, we consider the formal relationships that link the reasons or evidence given in the premise statements to the conclusion that they are said to support. If that structure is solid we can draw the conclusion forward, literally pulling it out of the premises. Such an argument is called valid. If the reasons or evidence offered do not support the conclusion that is being argued for, then we say the argument or reasoning is invalid. This level of flaw can be difficult to detect because an argument's structure can be easily hidden or glossed over with clever or sloppy use of language. Each of these three different facets of an argument can be considered separately, and each appeals to different standards or criteria of evaluation. Of the three, logicians are primarily interested in structure because quality at this level determines the foundational integrity of an Quick Review: Important Distinctions (be sure you can explain these): reason vs. argument, premise vs. conclusion form vs. content analysis vs. evaluation Be sure you can: Explain the subject matter of Logic define reasoning and argument Explain how reasoning and argument are related Identify some benefits to studying Logic and argument Explain why arguments can be difficult to evaluate Identify and explain the three perspectives from which an argument can be evaluated argument. To understand why logicians place such importance on argument structure we can compare an argument's structure to the foundation of a house. We may be impressed with the outward appearance of a house but its integrity will be found in its foundation. If there are serious flaws at this level – if the plumbing is corroded and the foundation termite ridden – then no matter what it looks like, the house will not be judged to be worth the investment. The same holds for an argument. We may like the argument's facade. We may feel it makes sense. We may agree with the statements it contains or be persuaded by the force of its presentation. But, if we find that the structure of the argument is flawed, the argument fails in a critical sense and does not present an example of good reasoning. In deductive logic our first interest is in the structure of arguments. This structure is found in the relationships between the premise and conclusion statements. The premise statements should have a relationship that is strong enough to support the conclusion. The emphasis on argument structure means we must

Analyze Before we Evaluate

This encourages us to look at what the argument presents, what statements it contains, and what structure those statements show, before we judge the argument as good or bad. Because argument structure can be difficult to see, we have to look beneath an argument's initial presentation. Logicians have developed tools that reveal the structure of arguments, and we will be learning how to use these tools in this course. We will work primarily with simple argument patterns, to help us learn how we can analyze arguments and assess the quality of their structure. Our first step will be to break arguments into their separate statements, and identify how those statements function as either premises or conclusion. We will then learn how to use logical languages to reveal underlying patterns in argument structure.

Soundness and Strength of an Argument

The soundness and strength of an argument depends upon the claim of the premises. if an argument is valid and its premises are true, we may be certain that its conclusion is true also. To put it another way: if an argument is valid and its conclusion id false, not all of its premises can be true. Some perfectly valid arguments do have false conclusions but any such argument must have at least one false premise. Moreover, when an argument is valid, and all of its premises are true, we call it sound argument and the strength of the argument depends upon the validity and in validity. Since the premises of the deductive arguments are strong enough for the inference of making conclusion. The conclusion of a sound argument obviously must be true and only a sound argument can establish the truth of its conclusion. If a deductive argument is not sound that is, if the argument is not valid or if not all of its premises are true then it fails to establish the truth of its conclusion even if in fact the conclusion is true. Thus we may say that inductive arguments may be ‘better’ or ‘worse’ and ‘weaker’ or ‘stronger’ and so on. in inductive argument, when the premises are all true and provide very strong support for the conclusion, that conclusion is not established with certainty. It is always possible in inductive argument that additional information will strengthen or weaker the argument. Newly discovered facts may cause us to change our estimate of the probabilities, and thus may lead us to judge the argument towards strengthen it or make it weak.

Fairness and Sensitivity

Fairness is a social rather than a psychometric concept. Its definition depends on what one considers to be fair. Fairness has no single meaning and, therefore, no single definition, whether statistical, psychometric, or social. The Standards notes four possible meanings of “fairness.” The first meaning views fairness as requiring equal group outcomes (e.g., equal passing rates for subgroups of interest). The Standards rejects this definition, noting that it has been almost entirely repudiated in the professional testing literature. It notes that while group differences should trigger heightened scrutiny for possible sources of bias (i.e., a systematic error that differentially affects the performance of different groups of test takers), outcome differences in and of themselves do not indicate bias. It further notes that there is broad agreement that examinees with equal standing on the construct of interest should, on average, earn the same score regardless of group membership. The second meaning views fairness in terms of the equitable treatment of all examinees. Equitable treatment in terms of testing conditions, access to practice materials, performance feedback, retest opportunities, and other features of test administration, including providing reasonable accommodation for test takers with disabilities when appropriate, are important aspects of fairness under this perspective. There is consensus on a need for equitable treatment in test administration (although not necessarily on what constitutes equitable treatment). The third meaning views fairness as requiring that examinees have a comparable opportunity to learn the subject matter covered by the test. However, the Standards notes that this perspective is most prevalent in the domain of educational achievement testing and that opportunity to learn ordinarily plays no role in determining the fairness of employee selection procedures. One exception would be settings where the organization using the tests purposely limits access to information needed to perform well on the tests on the basis of group membership. In such cases, while the test itself may be unbiased in its coverage of job content, the use of the test would be viewed as unfair under this perspective. The fourth meaning views fairness as a lack of predictive bias. This perspective views predictor use as fair if a common regression line can be used to describe the predictor-criterion relationship for all subgroups of interest; subgroup differences in regression slopes or intercepts signal predictive bias. There is broad scientific agreement on this definition of predictive bias, but there is no similar broad agreement that the lack of predictive bias can be equated with fairness. Thus, there are multiple perspectives on fairness. There is agreement that issues of equitable treatment, predictive bias, and scrutiny for possible bias when subgroup differences are observed, are important concerns in personnel selection; there is not, however, agreement that the term “fairness” can be uniquely defined in terms of any of these issues. Bias The Standards notes that bias refers to any construct

Sensitivity is one of four related statistics used to describe the accuracy of an instrument for making a dichotomous classification (i.e., positive or negative test outcome). Of these four statistics, sensitivity is defined as the probability of correctly identifying some condition or disease state. For example, sensitivity might be used in medical research to describe that a particular test has 80% probability of detecting anabolic steroid use by an athlete. This entry describes how sensitivity scores are calculated and the role of sensitivity in research design. Sensitivity is calculated based on the relationship of the following two types of dichotomous outcomes: (1) the outcome of the test, instrument, or battery of procedures and (2) the true state of affairs. Sensitivity (also called the true positive rate, the recall, or probability of detection in some fields) measures the proportion of actual positives that are correctly identified as such (e.g., the percentage of sick people who are correctly identified as having the condition).

Sensitivity refers to the test's ability to correctly detect ill patients who do have the condition.[5] In the example of a medical test used to identify a disease, the sensitivity (sometimes also named as detection rate in a clinical setting) of the test is the proportion of people who test positive for the disease among those who have the disease. Mathematically, this can be expressed as:

$$\textbf{Sensitivity} = \frac{\text{No. of true positives}}{\text{No. of true positives + No. of false negatives}}$$

$$= \frac{\text{No. of true positives}}{\text{Total number of sick individuals in population}}$$

= Probability of a positive test given that the patient has the disease

A negative result in a test with high sensitivity is useful for ruling out disease. A high sensitivity test is reliable when its result is negative, since it rarely misdiagnoses those who have the disease. A test with 100% sensitivity will recognize all patients with the disease by testing positive. A negative test result would definitively rule out presence of the disease in a patient.

A positive result in a test with high sensitivity is not useful for ruling in disease. Suppose a 'bogus' test kit is designed to show only one reading, positive. When used on diseased patients, all patients test positive, giving the test 100% sensitivity. However, sensitivity by definition does not take into account false positives. The bogus test also returns positive on all healthy patients, giving it a false positive rate of 100%, rendering it useless for detecting or "ruling in" the disease.

Sensitivity is not the same as the precision or positive predictive value (ratio of true positives to combined true and false positives), which is as much a statement about the proportion of actual positives in the population being tested as it is about the test.

The calculation of sensitivity does not take into account indeterminate test results. If a test cannot be repeated, indeterminate samples either should be excluded from the analysis (the number of exclusions should be stated when quoting sensitivity) or can be treated as false negatives (which gives the worst-case value for sensitivity and may therefore underestimate it).

Evaluating Decision Making from Multiple Perspectives

Decision making is the process of making choices by identifying a decision, gathering information, and assessing alternative resolutions. Decision making is a central responsibility of managers and leaders. It requires defining the issue or the problem and identifying the factors related to it. Doing so helps to create a clear understanding of what needs to be decided and can influence the choice between alternatives. An important aspect of any decision is its purpose, or objective. This is different from identifying a specific decision outcome; rather, it has to do with the motivation to make the decision in the first place. For instance, customer complaints can imply the need to change aspects of how service is delivered, so decisions must be made to address them. Factors that are not related to service delivery would not be in consideration in that decision.

There are a number of ways to define a problem, such as creating a team to tackle it and gathering relevant data by interviewing employees and customers. It is a good idea to be able to approach decision definition from different perspectives. Doing so can capture dimensions of the issue that might otherwise have been overlooked. Involving two or more people can bring different information, knowledge, and experience to a decision. This can be accomplished through forming a group to consider and define the problem or issue, and then to frame the decision based on their collective ideas. Having a shared definition and understanding of a decision helps the decision-making process by creating focus for discussions and making them more efficient.

Most decisions require a good understanding of the current state in order to understand all implications of the potential choices. For this reason it can be valuable to consider the views of all parties that will be affected by the decision. These may include customers, employees, or suppliers. Data should be gathered on how the current problem is affecting people now. Some examples of important data to gather include efficiency levels, satisfaction levels, and output metrics. Interviews, focus groups, or other qualitative methods of data collection can be used to identify existing conditions that may be connected to the decision in question. As much information as possible should be gathered to build confidence that a decision has been accurately and appropriately formulated before additional analysis and assessment of alternatives begin. Identifying a range of potential choices is essential to any decision-making process. When a decision maker has successfully and accurately defined the problem and generated alternatives, he or she can then conduct analysis useful to evaluating and assessing each. This typically involves analysis of quantitative data such as costs or revenues. Qualitative data is also used to be sure that considerations such as consistency with strategy, effects on relationships, or ethical implications are taken into account.

Once a decision has been defined, the next step is to identify the alternatives for decision makers to select from. It is rare for there to be only one alternative; in fact, a goal should be to identify as many different alternatives as possible without making too narrow a distinction between them. The decision maker can then narrow the list based on analysis, resource limitations, or time constraints. Often, doing nothing is an alternative worthy of consideration. Brainstorming is a good technique for identifying alternatives. Making lists of possible combinations of actions can generate ideas that can be shaped into alternatives. Often this is best done with a small group of people with different perspectives, knowledge, and experience. A formal approach to capturing the results of brainstorming can help make sure options are not overlooked.

Once decision alternatives have been identified and analyzed, the decision maker is ready to make a choice. To do so it is important to have a set of criteria against which to evaluate and even rank the alternatives. Selection criteria might include total cost, time to implement, risk, and the organization's ability to successfully implement the decision. Categorizing criteria in terms of importance helps to differentiate between options that might have similar disadvantages but different advantages, or vice versa. For example, consider two alternatives that are equally risky, but one will cost more and the other will take longer to implement. In this case, the decision would depend on whether cost or time is more important. On occasion, decision makers may believe they do not have sufficient information about a particular alternative, so additional analysis may be needed.

Decision makers should do their best to minimize their biases, or preconceived ideas about which alternative is preferable, until they complete the analysis. The benefit of using data to support decisions is that when analysis is done correctly it is objective and factual, not based on emotions or subjective preferences. While it is natural to have biases based on experience or feelings, it is important for managers and leaders to recognize them and take steps to keep them from butting their judgment. People may be unable to eliminate all of their biases, especially when it comes to their tolerance for risk. It is therefore important to be explicit about assumptions and biases to the extent possible, so that people involved in making the decision are aware of them and can adjust their deliberations accordingly. Decision makers must evaluate the results of a decision to improve the processes and outcomes of future decisions.

Decision making is a step by step process and it has seven steps. A step-by-step decision-making process can help you make more deliberate, thoughtful, decisions by organizing relevant information and defining alternatives. This approach increases the chances that you will choose the most satisfying alternative possible.

Step 1: Identify the decision

You realize that you need to make a decision. Try to clearly define the nature of the decision you must make. This first step is very important.

Step 2: Gather relevant information

Collect some pertinent information before you make your decision: what information is needed, the best sources of information, and how to get it. This step involves both internal and external "work." Some information is internal: you'll seek it through a process of self-assessment. Other information is external: you'll find it online, in books, from other people, and from other sources.

Step 3: Identify the alternatives

As you collect information, you will probably identify several possible paths of action, or alternatives. You can also use your imagination and additional information to construct new alternatives. In this step, you will list all possible and desirable alternatives.

Step 4: Weigh the evidence

Draw on your information and emotions to imagine what it would be like if you carried out each of the alternatives to the end. Evaluate whether the need identified in Step 1 would be met or resolved through the use of each alternative. As you go through this difficult internal process, you'll begin to favor certain alternatives: those that seem to have a higher potential for reaching your goal. Finally, place the alternatives in a priority order, based upon your own value system.

Step 5: Choose among alternatives

Once you have weighed all the evidence, you are ready to select the alternative that seems to be best one for you. You may even choose a combination of alternatives. Your choice in Step 5 may very likely be the same or similar to the alternative you placed at the top of your list at the end of Step 4.

Step 6: Take action

You're now ready to take some positive action by beginning to implement the alternative you chose in Step 5

Step 7: Review your decision & its consequences

In this final step, consider the results of your decision and evaluate whether or not it has resolved the need you identified in Step 1. If the decision has not met the identified need, you may want to repeat certain steps of the process to make a new decision. For example, you might want to gather more detailed or somewhat different information or explore additional alternatives.

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This book is an accessible text with readings for beginners of philosophy as well as for the students of other disciplines. This book offers a broad scope of different topics which includes; inductive logic, deductive logic, propositions, symbolic logic, predicate logic, modal logic and critical thinking skills. This book is simply prepared for all those students and scholars who are interested in the basics of Philosophy, logic, Mathematical logic and modal logic.

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