Traditional Logic

POST GRADUATE PROGRAMME IN PHILOSOPHY

Self Learning Material

M23PH03DC

SREENARAYANAGURU
OPEN UNIVERSITY

SREENARAYANAGURU OPEN UNIVERSITY

The State University for Education, Training and Research in Blended Format, Kerala

Vision

To increase access of potential learners of all categories to higher education, research and training, and ensure equity through delivery of high quality processes and outcomes fostering inclusive educational empowerment for social advancement.

Mission

To be benchmarked as a model for conservation and dissemination of knowledge and skill on blended and virtual mode in education, training and research for normal, continuing, and adult learners.

Pathway

Access and Quality define Equity.

Traditional Logic

Course Code: M23PH03DC

Semester-I

Discipline Core Course
Master of Arts Philosophy
Self Learning Material

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Message from Vice Chancellor

Dear

I greet all of you with deep delight and great excitement. I welcome you to the Sreenarayanaguru Open University.

Sreenarayanaguru Open University was established in September 2020 as a state initiative for fostering higher education in open and distance mode. We shaped our dreams through a pathway defined by a dictum 'access and quality define equity'. It provides all reasons to us for the celebration of quality in the process of education. I am overwhelmed to let you know that we have resolved not to become ourselves a reason or cause a reason for the dissemination of inferior education. It sets the pace as well as the destination. The name of the University centers around the aura of Sreenarayanaguru, the great renaissance thinker of modern India. His name is a reminder for us to ensure quality in the delivery of all academic endeavors.

Sreenarayanaguru Open University rests on the practical framework of the popularly known "blended format". Learner on distance mode obviously has limitations in getting exposed to the full potential of classroom learning experience. Our pedagogical basket has three entities viz Self Learning Material, Classroom Counselling and Virtual modes. This combination is expected to provide high voltage in learning as well as teaching experiences. Care has been taken to ensure quality endeavours across all the entities.

The university is committed to provide you stimulating learning experience. The PG programme in Philosophy is conceived to be a continuum of the UG programme in Philosophy as it has organic linkage with the content and the form of treatment. In fact is a progression of the finer aspects of theories and practices. Having realised the limitations of empirical methodology in exposing the concepts in Philosophy, the university has taken special care to follow illustrative methodology throughout the discussions. It is expected to a lessen the heaviness of the content. We assure you that the university student support services will closely stay with you for the redressal of your grievances during your studentship.

Feel free to write to us about anything that you feel relevant regarding the academic programme.

Wish you the best.

Regards,

Dr. P.M. Mubarak Pasha

01.12.2023

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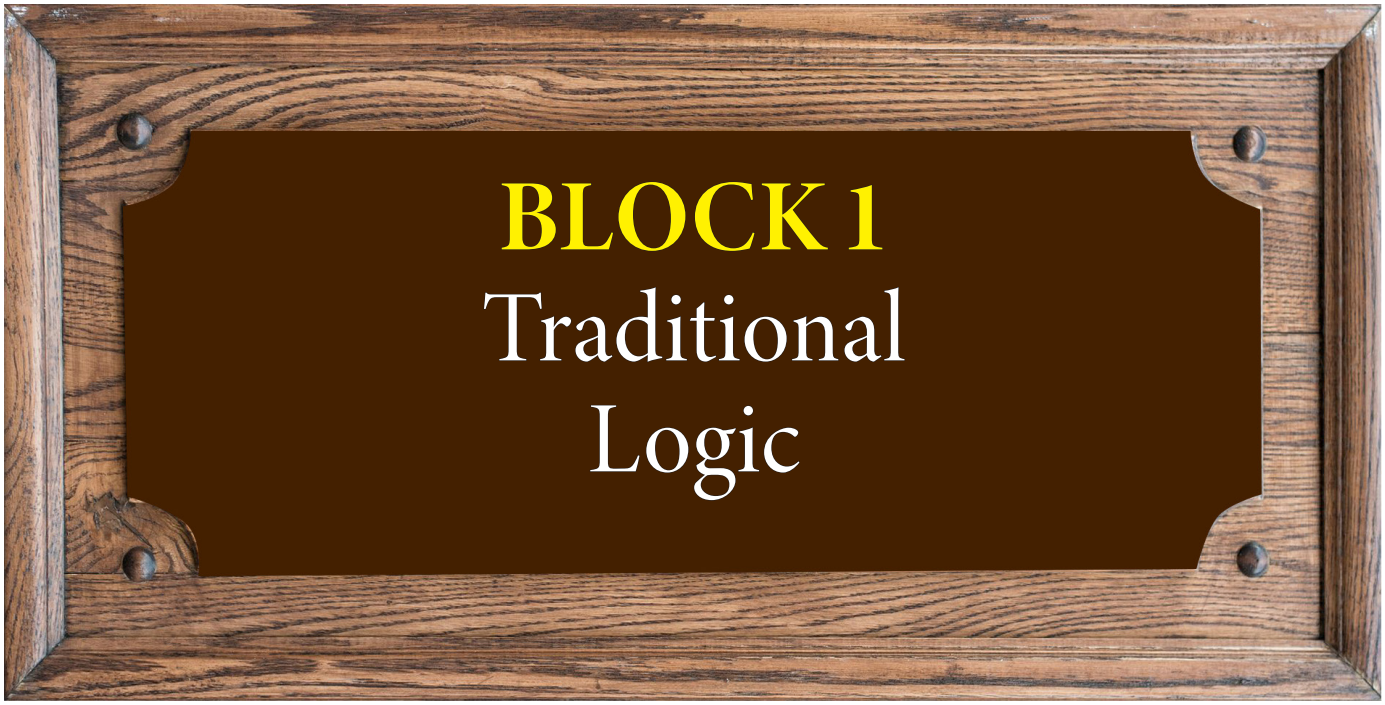

BLOCK 1
Traditional
Logic

UNIT 1
Introduction to Logic

Learning Outcomes

After completion of this unit, the learner will be able to:

- understand the origin of logic in the ancient Indian and Greek traditions and identify the significant contributions of ancient philosophers to the development of logic
- know the importance of logic in various fields of study
- evaluate the nature and scope of logic, and differentiate it from other fields of study
- analyse the principles of the Laws of Thought and their application in reasoning, problem-solving, and decision-making

Background

The primary task of philosophy is to enquire about the problems of life and the world by discussing concepts such as reality, knowledge, morality, death, and the meaning of life, etc. For this philosophical inquiry, thought plays a crucial role by helping us to analyse, evaluate, and synthesize the understanding. We develop beliefs, construct arguments, and present theories to make sense of our experiences. Logic, in particular, aids the thinking process by providing essential principles for reasoning, organizing thoughts, and evaluating the validity of arguments. Logic is the cohesive thread binding our thoughts together in a coherent manner. By adhering to logical principles, we ensure reliable inferences and avoid errors in our thinking. It serves as a guiding force for rational thought, enabling effective reasoning and leading to sound conclusions. Applying logic to our thoughts allows us to structure our ideas coherently and consistently and ensure their reliability. It helps us dissect complex problems,

identify connections among thoughts, and make informed judgments based on solid evidence and rational thinking. Thinking, as the fundamental cognitive process through which we engage with reality and seek comprehension, finds a valuable companion in logic, facilitating valid reasoning and upholding the integrity of our thoughts. Hence, understanding logic is necessary for philosophical inquiry.

Keywords

Reasoning, Argument, Deductive, Inductive, Inference

Discussion

1.1.1 What is Logic?

- Logic is a discipline concerned with thought

Logic is a branch of philosophy that focuses on the principles and methods of reasoning. It is the systematic study of the process of thinking. The term 'logic' originates from the Greek word 'logos,' which encompasses various meanings such as word, thought, speech, reason, energy, and fire. However, these literal interpretations have been abandoned in favour of more accurate meanings that capture the essence of studying logic. Over time, logic has come to be understood as a discipline concerned with thought, reasoning, and argumentation at different points in history.

- Only declarative sentences are logical

Emotional statements have no place in logic. Only statements that appeal to reason are considered fruitful and can be objectively verified and evaluated. Declarative sentences are the ones that fall under the scope of logic. Here, reason is used to justify and support conclusions when establishing arguments. However, not all reasons are good reasons. A correct reason is one in which the conclusion logically follows from the premises. Correct reasoning provides the only solid foundation for making judgments. Logic helps us distinguish between correct and faulty reasoning by discovering and establishing criteria for testing the correctness of arguments.

At the core of logic lies the concept of argument, which consists of a set of propositions or statements presented as evidence, along with a conclusion based on those propo-

sitions. Logic is a systematic study of the structure of arguments, how we evaluate them, and how we can arrive at sound conclusions based on the premises. Its goal is to provide us with tools to reason more effectively and critically. Throughout history, various definitions of logic have been proposed. Aristotle defined 'logic as the instrument (the 'organon') by means of which we come to know anything'. Leibniz viewed 'logic as the study of the principles of valid reasoning and inference, which he believed could be formalised and made more precise through symbolic notation'.

- Logic is the systematic evaluation of arguments

According to Russell, "Logic is the study of how to reason correctly, systematically, and rigorously, providing a clear and organised method of reasoning". For Aldrich, "logic is the art of reasoning", Whately says, "logic is the art and science of reasoning". However, these two definitions are considered defective because they confine logic too narrowly to the realm of reasoning. Susan Stebbing in her 'A Modern Introduction to Logic' says, " a logical set of rules, the learning of which may fit someone to do something". In his book 'Introduction to Logic', H.W.B. Joseph says, 'thought, in its unqualified sense, is the central theme of logic'. These two definitions attribute logic to the realm of psychology, and hence inherently subjective.

- Logic: the art of reasoning

According to Thompson, logic is "the science of the laws of thought". The laws of thought encompass the laws of identity, excluded middle, and contradiction. While these laws may seem related to thought, they are actually concerned with the nature of statements rather than thought itself. Consequently, even in this sense, thought cannot be considered as part of logic. Some logicians have argued that 'logic is the science of inference". In inference also, the nature of subjectivity is well evident, because inference occurs when there is someone to infer. Inference is not completely absent from the domain of logic and it has a definite role in the development of logic. But these explanations are not entirely free from defects.

- Logic is the science of the laws of thought

It is important to understand that, in all cases, 'inference' signifies implication. Implication is the technical term used to describe the relationship between premises and conclusion. It refers to a particular kind of logical relationship between premises and conclusions, where the truth of the premises necessitates the truth of the conclusion. Inference depends on humans, while the implication is independent of individuals,

- Implication is independent of human intrusion

making logic objective. Therefore, when addressing the subject matter of logic, implication replaces inference. Logic is concerned with the presence or absence of implication, which is objective and independent of human interpretation.

A more acceptable definition of logic is that it pertains to the distinction between good and bad arguments. This distinction is the essence of logic. An argument establishes a relationship between premises and a conclusion. If the conclusion logically follows from the premises, the argument is considered to be good; otherwise, it is bad. Logic determines whether the conclusion genuinely follows from the premises by adhering strictly to rules. The psychological processes, such as imagination, regret, or daydreaming, differ from reasoning and are not studied by logicians. Reasoning involves solving problems and drawing conclusions from premises. This does not entail that studying logic does not guarantee flawless reasoning. But those who have studied logic are more likely, though not obligated, to reason correctly compared to those who have not explored the underlying principles of logical activity. Continuous practice enables them to identify good reasoning from faulty ones. It also helps to identify the fallacies which are raised during reasoning. But, the drawback of this definition is its subjectivity since reasoning depends on the individual who reasons. Without a reasoner, there is no reasoning. Therefore, this definition also falls short in its scope.

- Logic determines whether the conclusion genuinely follows from the premises

According to Crieghton, 'logic is the science which treats the operations of the human mind in the search for truth'. For Mellon, 'logic is the science which deals with the principles of correct thinking'. Gibson says, 'Logic is the science of right thinking'. The most acceptable explanation of logic focuses on the distinction between good and bad arguments. Logic is the science that treats the operations of the human mind in the search for truth, the science that deals with the principles of correct thinking, or the science of right thinking. These definitions highlight the objective nature of logic and its role in distinguishing valid reasoning from invalid reasoning.

- Logic is the science which treats the operations of the human mind in the search for truth

1.1.2 Nature and Scope of Logic

Science can be divided into two main categories: positive science and normative science. Positive science describes things as they are, while normative science tells us how things

- Positive science describes things as they are normative science tells how things ought to be

ought to be. Positive science, also known as natural science, studies the nature of things and provides a description of the facts in the world. On the other hand, normative science establishes standards or ideals that the studied facts should adhere to. It aims to understand the criteria or rules we should use when making judgments about what is valuable. Normative science guides us on how things should be in order to be considered good or beautiful. Ethics and aesthetics are examples of normative science because they teach us how things ought to be considered morally right or aesthetically pleasing.

- Logic sets standards for valid reasoning.

Normative science is also referred to as regulative or evaluative science because it directs its focus towards a standard and assesses the value of its subject matter based on that standard. It deals with ideals. In this sense, logic can be considered a normative science. The main goal of logic is to identify the general conditions for valid reasoning. When we discuss logic, we strive to apply these conditions to our arguments since there are objective relationships between statements. For our arguments to be valid, statements must have a specific structure and specific relationships with one another. These structures and relationships, known as pure forms, serve as standards in logic. Logic aims for truth as the ideal and teaches us how our thinking should be in order to attain the goal of truth.

- Logic possesses both normative and descriptive aspects.

If logic were a positive science, it would merely describe different argument forms. However, logic goes beyond that. Logicians seek to establish systems based on statements that are logically true and purely formal, without relying on specific situations. Logic also does not search for principles for value judgments because its fundamental premise is our ability to distinguish between valid and invalid arguments. Logicians clarify the principles involved in valid arguments. Therefore, the positive-normative distinction does not precisely apply to logic. Logic does not neatly fit into either the positive or normative science categories. It possesses both normative and descriptive aspects. Logic provides standards for reasoning and argumentation that are independent of specific situations. It is a field of study with practical applications in various areas, playing a crucial role in analysing arguments and making informed decisions based on evidence and sound reasoning.

1.1.2.1 Science or art? or both?

- Debate surrounding the classification of logic as a science or an art

The question of classifying logic as a science, or as an art, has sparked an ongoing debate. In ancient times, science encompassed the systematic study of various subjects, but it has since evolved into a distinct discipline with defined boundaries. Science, as currently understood, involves the acquisition of knowledge to explain phenomena. By this definition, logic is not considered a science. So, does this imply that logic is an art? Art is associated with practical action. If we consider logic as an art, it would be in a derivative sense. To determine whether logic is an art, we must examine its purpose. Does logic aim to provide knowledge about valid argument forms or improve our thinking abilities? It is widely acknowledged that studying logic enhances our reasoning skills. However, there is a limitation. Just as a moralist may not always act morally, a logician may not consistently employ logical reasoning. Therefore, studying logic primarily results in acquiring knowledge about valid argument forms, but it is not the responsibility of logic itself to ensure the practical application of this knowledge.

- Science is theoretical knowledge, while art is its practical application

Opinions differ on whether logic is a science, an art, or both. Some logicians argue that logic is a science, while others believe it to be an art. Some even propose that logic encompasses both aspects. According to this description, any discipline that systematically studies a subject matter is considered a science, like physics, which focuses on the study of the physical world. In contrast, art establishes rules for achieving specific goals, such as music. The distinction between art and science lies in their objectives. Science aims to acquire knowledge, while art aims to apply that knowledge practically. Science provides theoretical knowledge, while art provides rules for practical application, which can be learned through practice. Science deals with existing phenomena, while art is concerned with innovative methods. Science relies on fixed laws, while art is adaptable and ever-evolving.

Despite their differences, art and science are not mutually exclusive but interconnected. Art relies on scientific knowledge for progress and improvement. Theoretical knowledge of cameras, light waves, and colour, for example, contributes to advancements in the art of photography. Progress and development in practical fields often stem from scientific advancements. Similarly, the science of logic contributes to

- Logic is both a science and an art

the advancement of the art of debate. Science and art are intertwined, with science providing the theoretical foundation and art focusing on practical application. In view of these considerations, logic can be primarily classified as a science, as it possesses the characteristics of scientific study. However, logic also encompasses practical rules for discovering the truth, which aligns with the definition of art. This aspect of logic is known as the art of correct thinking. Therefore, logic can be viewed as both a science and an art, with its primary nature being scientific and its secondary nature being artistic.

1.1.2.2 Two Types of Logic

- Formal logic focuses on structure while material logic on content

There are two main types of logic: formal logic and material logic. Formal logic focuses on the structure or form of arguments, while material logic is concerned with the content of arguments. Formal logic deals with how we think; specifically, the way arguments are structured. It does not depend on the specific things we think about. For example, if an argument follows the rules of logic, it is considered true in formal logic. The actual subject matter of the argument is not important as long as it follows logical rules. Material logic, on the other hand, considers the specific content of arguments. It checks if the argument is true or false based on the particulars of the subject matter. In material logic, understanding the content is necessary to determine the truth or falsity of the conclusion.

For instance: In formal logic, two propositions can have the same structure (form) but differ in the specific things they refer to (matter). For example,

'All crows are black'
'All men are mortal'

Both have the same form but differ in the subject matter. Similarly, in material logic, two propositions can have the same subject matter (matter) but differ in their structure (form). For instance,

'All mammals are warm-blooded' and
'No mammals are cold-blooded'

Both refer to mammals but have different structures.

- Deductive logic is formal logic, while inductive logic is material logic

In deductive or formal logic, the truth of an argument is determined by the logical relationship between its premises and conclusion. It focuses solely on the form of the argument, not the specific details of the subject matter. In inductive or material logic, the truth or falsity of the conclusion depends on the specifics of the content of the argument. In it, knowing the subject matter is crucial to assessing whether the conclusion is true or false.

For example:

All birds can swim.
Penguins are birds.
Therefore, penguins can swim.

This argument is formally true because it follows the rules of logic. However, it is materially false because the premise 'All birds can swim' is not true in reality. This highlights the distinction between formal and material truth in logic. Logic is both formal and material. Some logicians, like Thompson and Hamilton, believed that logic is only concerned with the form of thinking, while others argued that form and matter are inseparable. Both aspects are important in understanding logic, as there can be no form without matter and vice versa. Therefore, logic encompasses both the structure of arguments and the specific content they refer to.

1.1.3 Laws of Thought

The laws of thought are the essential principles of logical reasoning. They have been studied by logicians and philosophers because they provide the foundation for all kinds of logical reasoning. They help evaluate the truth value of propositions and examine the validity of arguments. The laws of thought are an essential tool for those who want to develop strong, valid arguments. Without these laws, no correct thinking is possible. Aristotle identified three main laws of thought. They are:

1. The law of identity
2. The law of non-contradiction
3. The law of the excluded middle

1.1.3.1 The Law of Identity

The law of identity is a principle that asserts the identity of each thing to itself, represented by the statement 'A is A'.

- The law of identity asserts that each thing is what it is

However, this principle goes beyond mere repetition as it recognizes that identity can exist within difference and unity within diversity. The law of identity states that an object is what it is and not something else. For example, a crow is identical to itself and distinct from a parrot or any other bird. This law is crucial in reasoning as it allows us to differentiate between various objects and concepts. Any statement violating the Law of Identity cannot be true, and arguments based on such statements are imperfect.

- Identity persists through growth and change, balancing continuity and transformation.

An individual can undergo personal growth and change while still maintaining their core identity. Take, for example, the case of a motor bike. The components of the bike, including the engine, can be replaced or modified over time. Despite these changes, the bike is still recognized as the same entity it was before. True identity does not exclude differences; it encompasses the idea that while changes may occur, the essence or fundamental nature remains intact.

- A statement is true only if it accurately corresponds to reality

In the realm of deductive reasoning, we have observed that the terms used in arguments must possess consistent meanings. It ensures that a statement is true only if it accurately corresponds to reality. This requirement aligns with the law of identity, which affirms that every statement of the form 'P⊃ P' must be true. For instance, let us consider the proposition 'It is raining.' If this proposition accurately corresponds to the current weather conditions, then the statement 'It is raining' is true. The law of identity emphasises the logical coherence between the proposition and the actual state of affairs. The law of identity maintains logical consistency and ensures that our statements align with reality. It serves as a foundational principle for reasoning and supports our ability to distinguish between true and false assertions. Without the law of identity, our capacity to engage in meaningful discourse and construct valid arguments would be compromised.

1.1.3.2 The Law of Non-Contradiction

- Something cannot be both true and false simultaneously

The law of non-contradiction states that it is impossible for something to be both 'A and Not A' at the same time. This law asserts that an object cannot be both itself and something else at the same time. It affirms that for any proposition P, it is impossible for both P and 'not-P' to be true simultaneously within the same respect. In short, if P is true, then its contradictory proposition 'Not P' must be false and vice versa. For instance, the statements 'It is raining' and 'It is not raining'

cannot both be true simultaneously and in the same context. If 'It is raining' corresponds with the current weather outside, it is true. Then the proposition 'It is not raining' must be false at the same time. This law is valuable for evaluating arguments as it allows us to detect contradictions and inconsistencies in reasoning. An argument that violates the law of non-contradiction is considered invalid.

The law of non-contradiction finds wide applications in philosophy, mathematics, and science. In philosophy, it helps determine the logical consistency between two propositions. If they are not consistent, they cannot both be true. In mathematics, the law is used to establish the validity of proofs and the consistency of mathematical systems. In the realm of science, it is employed to assess the truth or falsehood of scientific theories. This principle asserts that a statement cannot be simultaneously true and false. Using symbolic notation, it can express the assertion that every statement of the form P.~P must be false, and such statements are inherently self-contradictory.

- Every statement of the form P. ~P must be false

1.1.3.3 The Law of Excluded Middle

The law of excluded middle states that for every proposition, either it is true or its negation is true. There is no middle ground between true and false. This law can be expressed as 'either A or not-A,' meaning that there is no middle ground between a proposition and its negation. That is for P, either P is true or not-P is true. For example, if the proposition 'she is a hosteler' is true, then the proposition 'she is a day scholar' is false. There is no middle ground between these alternatives. Among these contradictories, either one of them is true, and there is no third option. Critics of the Law of Excluded Middle argue that there may be cases where a proposition is neither true nor false, but rather indeterminate or vague. The principle of excluded middle asserts that every statement of the form P V ~P must be true and that every such statement is a tautology.

- Every proposition is either true or its negation is true, with no middle ground in between

The law of excluded middle is a fundamental principle of reasoning, as it allows us to make definitive statements about the truth or falsity of propositions. It forms the basis for many mathematical and logical operations, and it allows us to evaluate the validity and soundness of arguments.

Summarized Overview

Logic provides us with a systematic approach to philosophical analysis. It offers rules and principles that guide reasoning and argumentation, enabling the careful division of complex ideas, identification of fallacies, and uncovering of hidden assumptions. This critical examination leads to a deeper understanding of concepts and helps us to avoid errors in reasoning. Furthermore, logic promotes intellectual rigour and precision in our philosophical as well as daily discussions. It allows us to articulate ideas with clarity and coherence, and construct valid and sound arguments that foster meaningful dialogue and exploration of different perspectives. Logic assists us in having systematic and disciplined thought processes and facilitates the methodical analysis of concepts and propositions. This systematic approach enhances our understanding and enables a more rigorous philosophical inquiry.

The study of logic is indispensable in philosophical inquiry. It empowers philosophers with tools to analyse, evaluate, and synthesise complex ideas and ensures coherence, consistency, and validity in thinking. It provides a solid foundation for philosophical exploration and promotes intellectual rigour and precision. Through logical principles, philosophers can solve problems by developing well-structured arguments, critically examining perspectives, and striving for clarity and rationality in their philosophical endeavours. By understanding terms and propositions, we get a deeper understanding of how logic operates in philosophical analysis.

Assignments

1. Discuss different definitions of Logic by prominent philosophers and their contributions to the development of Logic.

2. Discuss the interplay between science and art in the field of logic. Provide examples to illustrate how logic can be both a science and an art.

3. Compare and contrast formal and material logic, highlighting their distinctive features and applications.

4. Explore the application of the law of identity in the context of personal growth and change. How does this law align with the idea that identity can exist within difference?

Self-Assessment

1. What is logic? Is it a science or art or both? Explain.
2. Differentiate between formal logic and material logic. Provide examples to illustrate each type.
3. What is the nature and scope of logic?
4. Explain the law of non-contradiction and its significance in logical reasoning.
5. How does the law of the excluded middle contribute to making definitive statements about the truth or falsity of propositions?

Reference

- Ganeri, J. (2019). "Indian Logic", The Stanford Encyclopedia of Philosophy (Summer 2019 Edition) edited by E. N. Zalta.
- Gottschalk, H. (2017). "Logic in ancient India". The Stanford Encyclopedia of Philosophy (Winter 2017 Edition) edited by E. N. Zalta.
- Copi, I. M., & Cohen, C. (2017). *Introduction to Logic.* Routledge.
- Lemmon, E. J. (1965). *Beginning Logic*. Nelson.
- Sider, T. (2010). *Logic for Philosophy*. Oxford University Press.

Suggested Reading

- Graham, G. (2018). "The laws of thought", Routledge Encyclopedia of Philosophy. Routledge.

Space for Learner Engagement for Objective Questions

Learners are encouraged to develop objective questions based on the content in the paragraph as a sign of their comprehension of the content. The Learners may reflect on the recap bullets and relate their understanding with the narrative in order to frame objective questions from the given text. The University expects that 1 - 2 questions are developed for each paragraph. The space given below can be used for listing the questions.

UNIT 2
Terms

Learning Outcomes

After the end of the unit, learner will be able to:

- understand the concept of terms in language and reasoning
- differentiate between words, concepts, and terms
- classify terms based on their structure, meaning, and function
- understand the concepts of extension and intention of terms, and be able to distinguish between them

Background

The foundation of effective communication and logical analysis relies on fundamental linguistic units that act as the basic atoms of language. The linguistic units, often referred to as terms, play a crucial role in expressing and conveying the proper meaning. Terms encompass a wide range of words or phrases that represent concepts, objects, qualities, or ideas. By utilising terms accurately and precisely, individuals can communicate their ideas effectively and ensure clarity in their expressions. Terms act as guideposts in the web of thoughts and ideas, helping us navigate complex concepts and articulate our understanding. They provide a shared vocabulary that allows us to classify and categorise things and facilitates our ability to communicate and comprehend various subjects. Just as a builder needs a solid foundation to construct a strong building, understanding terms is vital for constructing strong arguments and fostering effective communication. By studying terms, we can unlock the power of precise language.

Keywords

Abstract, Concrete, Connotation, Denotation, Singular, General, Collective

Discussion

1.2.1 Terms

- Terms are essential components of propositions

The taste and quality of a dish heavily depends on the ingredients used. The choice of ingredients directly impacts the actual taste and overall quality of the dish. Without these essential ingredients, the dish cannot be prepared, as they serve as the building blocks that give it its distinct characteristics. Similarly, in the realm of language and reasoning, terms act as the foundational components that express specific meanings. They serve as the building blocks of language and allow for the precise expression of ideas. The word 'term' originates from the Latin word 'terminus,' which means a limit or boundary. Terms limit the scope of thought. Propositions are units of reasoning, and terms are essential components of propositions. It is essential to understand the terms in constructing and evaluating arguments in logic. The proposition is a statement in an argument, which says something about something else, either positively or negatively. The subject of the proposition is the thing being talked about, and the predicate is what is said about the subject. For example, in the proposition 'Santhra is intelligent', 'Santhra' is the subject term and 'intelligent' is the predicate term. Both subject and predicate terms are considered as terms. Terms can be single words or groups of words.

- Term is the linguistic expression of the concept

It is important to note that all terms are words, while, all words are not terms. To distinguish between words, concepts, and terms, it is important to clarify their meanings. The concept refers to a general idea, which is a mental entity. Concepts are formed by identifying the common and essential attributes shared by all individuals within a class. A word, on the other hand, is a unit of language that conveys a specific meaning. It consists of a letter or combination of letters conveying determinate meaning. But a term is a linguistic expression of the concept. When we express concepts in language, they become terms that can be used in judgments or propositions. The term is a word, or a combination of words, which by itself is capable

of being used as the subject or predicate of a logical proposition. Terms are classified into different types based on their structure, meaning, and function.

1.2.2 Classification of Terms

- Logic encompasses different types of terms

Understanding and categorising terms in logic is crucial as it offers a structure to analyse and evaluate arguments. By understanding the different types and properties of terms, one can identify the errors and mistakes in reasoning and in the construction of valid arguments. Logic encompasses different types of terms, such as singular, general, abstract, concrete, positive, and negative terms, each with distinct qualities and purposes in logical analysis.

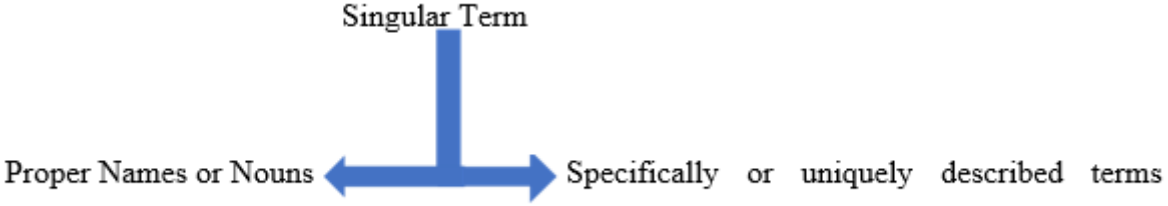
1.2.2.1 Singular Term

- Singular terms refer to individual objects or entities

In order to depict a person or an object, what kind of term do we use? Here, we employ singular terms for clarity and precision. Singular terms allow us to pinpoint and uniquely identify an individual or thing. Singular terms refer to individual objects or entities, representing a single person, object, or thing in a specific sense. Examples of singular terms include 'Radha', 'The Potato Eaters', and 'Mount Aravalli', which denote specific entities. These terms are often used in logical propositions to assert specific statements about individuals. For instance, the proposition 'Sheena is a doctor' uses the singular term 'Sheena' to refer to a particular person and state their profession. Singular terms are considered extensional, referring to specific individuals or objects in the world. They can only be applied to one object at a time and in the same sense, encompassing persons, places, qualities, events, and other individual entities.

Singular terms are of two types.

1. Proper names or nouns
2. Specifically or uniquely described terms



- Proper names are singular terms associated with specific individuals

Proper names are a type of singular term permanently associated with a specific person, place, or object. They uniquely belong to and identify with one entity, even if there are multiple entities with the same name. For example, names like 'John,' 'Riya' and 'Chennai' are proper names that distinguish and refer to particular individuals. On the other hand, specifically or uniquely described terms are not proper names but have unique references due to specific attributes present in the object they denote. These terms highlight distinct qualities or characteristics, enabling them to refer to a single individual or object. Examples include 'The Chief Minister of Kerala', 'The Highest Mountain Range', and 'The World War of 1914 to 1918'.

1.2.2.2 General Term

- General terms represent a group of things that have common properties

General terms are used to represent a group of things that have common properties or characteristics. These terms help us to make general statements about these groups. For example, words like 'cat', 'crow', 'lawyer', 'painting', and 'mountain' are general terms because they refer to categories of things with shared features. For instance, the term 'cat' represents a group of animals that have fur, four legs, tails, and eat fish. We often use general terms to make general claims. For instance, when we say 'All lions are carnivores', we are using the general term 'lion' to refer to all members of that particular group and stating that they are all meat-eaters. General terms are like labels that describe a set of characteristics or properties that define a specific class or group of things. For instance, the term 'lawyer' refers to people who have a law degree and work in the legal profession.

- General terms are names that can be applied to multiple similar objects

General terms are names that can be applied to multiple similar objects, representing each member of a class. They are often called common terms because they are shared by many objects. Sometimes, even proper names can be used as general terms, like 'A Daniel', 'A Shakespeare', 'A Socrates', etc. These expressions can be used to describe individuals who possess qualities similar to those historically associated with Daniel, Shakespeare, and Socrates respectively. The term 'A Daniel' serves as a general term to depict any person who embodies the virtues of justice and fairness. It does not refer to a specific individual named Daniel but instead employs the name as a representation of a particular set of qualities or attributes. Thus, when we say 'A Daniel', we indicate someone who demonstrates fairness and justice, regardless of their name. The term 'A Daniel' can be used as a general term for

any person who is just or fair.

1.2.2.3 Collective Term

- Collective terms describe groups of individuals or objects, enabling statements about the collective entity as a whole.

Collective terms are words used to describe a group or collection of individuals or objects, like 'herd', 'flock', 'team', and 'group'. These terms represent a set of things rather than focusing on individual members. For instance, the word 'herd' refers to a group of animals, like cows or sheep, that are kept together for farming purposes. Collective terms are often used to make statements or claims about groups of individuals or objects. For example, if we say, 'The team won the match', we are using the collective term 'team' to refer to a group of individuals who played together in a sporting competition and asserted their victory in the championship.

- Collective terms refer to groups of people, objects, or entities as a whole.

Collective terms apply to groups of people, things, or objects as a whole, rather than considering each individual separately like 'society', 'library', 'parliament', 'army', and 'assembly'. These terms encompass the entire group or unit. It is important to note that collective terms can be either singular or general. A singular collective term refers to a specific group, such as 'The Sreenarayanaguru Open University' or 'The Student Police Cadet'. On the other hand, a general collective term refers to multiple collections or groups, like saying 'Universities are important institutions.'

1.2.2.4 Concrete and Abstract Terms

- Concrete terms are tangible and perceptible objects, while abstract terms represent intangible concepts.

Concrete terms refer to objects or things that can be experienced through the senses. Concrete terms denote specific things, objects, persons, or articles. Examples of concrete terms include words like 'chair,' 'cat,' and 'tree.' These terms can be perceived directly and are often physical or tangible in nature. Abstract terms, on the other hand, represent concepts or ideas that cannot be directly perceived. It refers to abstract entities, characteristics, or attributes. Words like 'freedom,' 'love,' 'truth,' and 'happiness' are examples of abstract terms. They refer to subjective or intangible concepts. Abstract terms are commonly used in logical propositions to make statements or claims about ideas or concepts, while concrete terms are used to describe or refer to physical objects. For instance, when we say, 'Justice is important for a good society,' we are using the abstract term 'justice' to refer to a concept and emphasise its significance in creating a just society.

In logical analysis, concrete terms are treated as extensional terms, referring to physically perceptible objects. On the other hand, abstract terms are treated as intentional terms, representing concepts defined by specific properties or characteristics. It is important to note that not all adjectives are abstract terms. While 'happy' is not an abstract term, 'happiness' is. An abstract term represents a quality or concept by itself, independent of specific objects. For instance, in the proposition 'Crows are black', the word 'black' is not an abstract term because it refers to the quality of blackness that qualifies the crows. However, 'blackness' is an abstract term because it represents the quality itself. In a proposition, both the subject and predicate terms should be nouns. If they are not, they need to be transformed into appropriate nouns. For example, the proposition 'Crows are black' can be expanded to 'Crows are black coloured birds', where both the subject term 'crows' and the predicate term 'black coloured birds' are concrete terms.

1.2.2.5 Positive and Negative Terms

Positive terms affirm the presence of quality or characteristics in an object which it denotes. In logical analysis, positive terms are treated as affirmative predicates, asserting the existence of a quality. Words like 'truth', 'healthy', and 'alive' are examples of positive terms, because they assert the existence of a particular quality in the concerned objects. While negative terms deny the presence of certain qualities in the concerned object that it depicts. The negative terms are treated as negative predicates, denying the existence of a quality. The words like 'false', 'invisible', and 'dead' are negative terms, as they negate the presence of certain qualities. These positive and negative terms are often used in logical propositions to make claims about the presence or absence of qualities or characteristics. Negative terms are often formed by adding prefixes like 'in,' 'un', 'dis', 'anti', 'non', 'mis', or the suffix 'less'. Some words may appear positive in form but have negative meanings, like 'ignorance' or 'darkness'. Conversely, there are words that appear negative but have positive meanings, such as 'priceless' or 'invaluable'. It is the meaning, rather than the form, of a term that determines its positive or negative characteristics. However, negative terms also point to the presence of something else while showing the absence of something, like the term 'immoral' indicating the presence of immorality alongside the absence of morality.

- Positive terms affirm the presence of qualities, negative terms deny their presence.

Positive and negative terms have a contradictory relationship because they mutually exclude each other. Contradictory terms mutually exclude each other, allowing no middle ground. For example, a person can be either alive or dead, honest or dishonest, married or single. Contrary terms, on the other hand, have a degree of difference between them and admit a middle ground. For instance, terms like 'rich' and 'poor' or 'wise' and 'foolish' allow for varying degrees between them. There may be a middle ground between these two extremes. Contradictory terms require denying one when affirming the other. Contradictory terms are formed by adding prefixes like 'non', 'not', or 'other than' to positive terms. For example, the contradictory term 'Indians' could be 'non-Indians', 'not Indians', or 'other than Indians'. Privative terms fall between positive and negative terms. They indicate the absence of a quality that is typically expected to be present in an object. Examples of privative terms are 'blindness,' 'deafness,' and 'handicap.'

- Privative terms indicate the absence of an expected quality

1.2.2.6 Absolute and Relative Terms

Absolute terms are concepts or ideas that stand on their own, independent of any specific context or reference point, and have a clear meaning. These terms possess universal meanings like 'book', 'tree' etc. These terms do not rely on any particular context for their understanding. The term 'absolute' is most accurately applied to the Supreme Being or God. Relative terms, on the other hand, are concepts or ideas that depend on a specific context or reference point. It derives its meaning from its relation to something else. Their meanings vary based on the situation in which they are used. Examples of relative terms are 'teacher', 'big', 'tall,' and 'rich'. These terms require a comparison or reference to understand their meaning fully. For instance, the term 'teacher' makes sense only in relation to the 'students', and the 'doctor' to the 'patient'. Relative terms are always used in pairs, known as co-relative terms, such as 'master-servant', 'doctor-patient', 'teacher-student' etc.

- Absolute terms have clear, universal meanings

Relative terms are often used in logical propositions to make comparisons or assertions about the relationship between different objects or concepts. They indicate a connection or comparison between two or more entities. For example, when we say 'Geetha is taller than Gopi' we are using the relative term 'taller' to compare the heights of Geetha and Gopi. Actually, nothing is entirely considered to be absolute in the universe. Even a tree, which is often considered absolute, is related to its seed. In the universe, everything is interconnected.

- Relative terms compare entities

Table 1.2.1 Classificatiuon of Terms with its Attributes

Classification of Terms	Attributes	Examples
Singular Term	Refer to individual objects or entities	Radha, Sheena, The Potato Eaters, Mount Aravalli
General Term	Refer to a group of things having common characteristics	Cat, Crow, Lawyer, Painting, Mountain
Collective Term	Indicates a group or collection of individuals or objects	Herd, Flock, Team, Group, Society, Parliament, Army, Assembly
Concrete Term	Refer to objects or things that can be experienced through the senses	Chair, Cat, Tree
Abstract Term	Concepts or ideas that cannot be directly perceived	Freedom, Love, Truth, Happiness, Blackness
Positive Term	Affirm the presence of quality in an object	Truth, Healthy, Alive
Negative Term	Deny the presence of a quality in an object	False, Invisible, Dead
Privative Term	Refer to the absence of a quality that is expected to be present in the object	Blindness, Deafness, Handicap
Absolute Term	Refer to concepts or ideas that stand on their own, independent of a specific context or reference point and have a clear meaning	Book, Tree
Relative Term	Make comparisons or assertions about the relationship between different objects or concepts	Teacher- Student Master-Servant Doctor- Patient

1.2.3 Denotation and Connotation of Terms

- Denotation indicates the quantity

Logicians aim to identify fallacies in reasoning and suggest remedies, such as addressing the wrong use of language. Ambiguous or vague terms should be avoided in propositions. Logicians have proposed two techniques to clarify the meaning of terms: denotative and connotative techniques. Denotation, also known as extension, indicates the denoted or represented actual objects or entities of the term. It refers to the set of signified things a term applies to. Denotation determines the applicability and extent of a term by defining its boundaries. For instance, the term 'human' denotes all human beings in the world.

- Connotation refers to the qualities

Connotation, on the other hand, refers to the qualities or attributes commonly connected to it. Connotation, also known as intention, relates to the attributes or characteristics associated with the term, which may or may not directly relate to its denotation. Connotation focuses on the essential characteristics shared by all members denoted by the term, disregarding non-essential qualities such as education, nationality, employment, or height. For example, the term 'human' has connotations like animality, mortality, and rationality; which are not inherent to the physical characteristics of humans.

- The relationship between denotation and connotation is influenced by context and culture.

Every term denotes objects and connotes specific qualities. The term 'lion' denotes all lions, whether they exist in the natural habitats of forests or are preserved in museums as taxidermy specimens. The connotation of the term 'lion' includes characteristics such as carnivorous nature, strength, courage, and being recognized as the apex predator in the animal kingdom. Similarly, the term 'University' denotes all universities, such as Sreenarayanaguru Open University, Kerala University, MG University, Kannur University, Calicut University, and others, irrespective of their specific characteristics. The connotations of the university include higher education, research and innovation, academic excellence, knowledge dissemination, etc. The relationship between connotation and denotation is complex and changes over time and across different contexts and cultures. The connotation of a term can alter or change, potentially overshadowing its denotation and influencing its meaning and usage.

Three types of connotations are generally recognized: subjective, objective, and conventional. Logicians are primarily concerned with conventional connotations.

1.2.3.1 Subjective Connotation

- Connotations vary across cultures

Subjective connotation arises when a term conveys different characteristics among different groups of people. In such cases, there is no fixed or common connotation. For example, the term 'married women in white clothes' connotes sorrow in India (widowhood), but happiness in western countries (wedding dress). Likewise, in certain countries, the term 'white long cloth' may connote a Church Father, representing spiritual authority, while in other countries, it may connote a Muslim man wearing a white thawab, symbolising cultural and religious adherence. The 'white long cloth' connotations can vary depending on the specific country and its cultural context.

1.2.3.2 Objective Connotation

Objective connotation occurs when a term refers to all known and unknown characteristics. However, humans can never be certain if they know all the characteristics.

1.2.3.3 Conventional Connotation

Conventional connotation refers to the set of known and common characteristics possessed by all members denoted by a term. Accepted and agreed-upon qualities of a term help avoid the pitfalls of subjective and objective connotations.

The relationship between denotation and connotation is inversely variable. As the connotation of a term increases, the denotation tends to decrease. For instance, the denotation of the term 'vehicle' encompasses various modes of transportation, such as cars, motorcycles, bicycles, buses, trains, planes, and more. However, if we add the connotation of 'electric-powered', the denotation becomes narrower and includes only electric cars, electric motorcycles, electric bicycles, and so on. Adding another connotation, such as 'four-wheeled', further narrows down the denotation to include only four-wheeled electric vehicles. As each additional connotation is introduced, the denotation becomes more specific and the category of individuals being referred to becomes narrower. This narrowing down of the denotation is a result of the increasing specificity and refinement brought by the added connotations.

- Connotation and denotation have an inverse relationship

According to Mill and many logicians, terms can be categorised as connotative or non-connotative. A connotative term denotes an object and connotes attributes, representing both the object and its qualities. On the other hand, a non-connotative term focuses on either the object or the qualities. Proper names and singular abstract terms are considered non-connotative. Proper names merely indicate objects without common qualities to connote, while singular abstract terms only express qualities without objects.

Summarized Overview

Terms are fundamental linguistic units that carry meaning and play a vital role in communication. They represent concepts, objects, qualities, or ideas, enabling us to express our thoughts and convey meaning effectively. Terms help us to classify, categorise, and articulate our ideas with clarity and precision. Understanding the nature and application of terms forms the basis for exploring the concept of propositions. Meaningful logical statements are formed by combining terms, and these statements are explored in the study of propositions. By grasping the significance of terms, we lay the groundwork for constructing valid and sound arguments and utilise propositions as the building blocks of logical reasoning.

Self-Assessment

1. Define the 'term' in logic
2. Explain how terms act as the foundational components in language and reasoning.
3. Write a note on the 'classification of terms'.
4. What is the difference between singular and general terms?
5. Make a note on concrete and abstract terms.
6. Distinguish between proper names or nouns and specifically or uniquely described terms, providing examples for each.
7. What is the difference between Denotation and connotation of terms?
8. Give a detailed account of the classification of terms with examples.
9. Make a brief note on absolute and relative terms with examples.

Assignments

1. How do connotation and denotation differ in meaning across various cultures? Explain their inverse relationship with an illustrative example.

2. Discuss the differences among words, concepts, and terms. Provide examples to illustrate each of these linguistic units and explain their relationships.
3. Provide an overview of the classification of terms along with specific features or attributes of each term that align with their respective classifications.

Reference

- Copi, I. M., & Cohen, C. (2017). *Introduction to Logic* (15th ed.). Routledge.
- Hurley, P. J. (2014). *A Concise Introduction to Logic* (12th ed.). Cengage Learning.
- Creighton, J. E., & Smart, J. J. C. (1973). *An Introduction to Logic* (2nd ed.). Routledge.
- Smith, H. (2013). *An Introduction to Formal Logic* (3rd ed.). Cambridge University Press.

Suggested Reading

- Kneale, W., & Kneale, M. (1984). *The Development of Logic*. Oxford University Press.

Space for Learner Engagement for Objective Questions

Learners are encouraged to develop objective questions based on the content in the paragraph as a sign of their comprehension of the content. The Learners may reflect on the recap bullets and relate their understanding with the narrative in order to frame objective questions from the given text. The University expects that 1 - 2 questions are developed for each paragraph. The space given below can be used for listing the questions.

UNIT 3
Propositions

Learning Outcomes

At the end of the unit, the learner will be able to:

- understand what propositions are, how they differ from other linguistic expressions
- identify different kinds of propositions based on quantity and quality
- know the distribution of terms in an argument
- enhance critical thinking and problem-solving skills by analysing Euler's circle

Background

Just as individual puzzle pieces come together to form a complete image, propositions serve as the building blocks that shape logical reasoning. Like a skilled detective who analyses evidence to solve a mystery, individuals can use propositions to unravel complex problems, draw accurate conclusions, and make well-informed decisions. Understanding propositions and their logical connections is a vital skill for reasoning effectively, evaluating arguments critically, and making rational judgments. Mastering proposition-based reasoning provides individuals with a powerful tool to navigate the web of knowledge, untangle complexities, and arrive at logical and well-supported conclusions. By doing so, individuals can piece together the puzzle of information and make informed choices based on reason and evidence. The significance of propositions lies in their ability to mirror and explain the orderly arrangement of the world. They help to analyse concepts and construct arguments and enable us to organise our thoughts and formulate coherent ideas. By assigning truth values to propositions, we can make assertions about the world and establish logical connections between ideas. Propositions act as tools for exploring and comprehending reality, uncovering the underlying structure of our reasoning, and evaluating the strength of our arguments. They play a crucial role in logical reasoning and our understanding of the world through sound and rational judgments.

Keywords

Affirmative, Negative, Universal, Particular, Copula

Discussion

- Declarative sentences are propositions

A proposition is a meaningful statement that expresses something about a subject either positively or negatively but not about both simultaneously. For Aristotle, a proposition consists of a subject, a predicate, and a copula. The subject refers to the entity or thing the proposition is about, while the predicate provides information or attributes about the subject. The copula connects the subject and predicate, showing their relationship. For example, in the proposition, 'Man is mortal', 'Man' is the subject term, 'mortal' is the predicate term and 'is' is the copula. Propositions are the fundamental unit or building block of logical reasoning and argumentation. They are used to form arguments, where both premises and conclusions are propositions. The truth and validity of an argument depend on the truth or falsity of the propositions used. While propositions take the form of statements, not all sentences are propositions. Only declarative sentences that convey factual, informative, and indicative statements are considered propositions.

- All propositions are sentences while all sentences are not propositions

Sentences can take various forms, such as questions, exclamations, or commands, but these forms do not fall under the definition of propositions. Imperative (giving commands), exclamatory (expressing strong emotions), emotive (conveying feelings), and interrogative (asking questions), are different types of sentences. For instance, when someone says 'Shut the window,' or exclaims 'What a beautiful flower!'. These sentences are not expected to be true or false. They are commands or exclamations. Commands can be obeyed, and exclamations can be uttered, but they cannot be judged as true or false. In contrast, propositions have a truth value and can be evaluated as either true or false. All propositions are sentences, while, all sentences are not propositions. A proposition is true if it accurately describes facts, and false if it does not. When one holds a conviction regarding the truth or falsehood of a sentence, those sentences attain the status of propositions due to their inherent truth values.

1.3.1 Classification of Propositions

- Simple proposition makes a single claim

Propositions can be classified into two types: simple propositions and complex (compound) propositions. Simple propositions make a single fact or claim without combining them with other propositions. For example, the statement 'Socrates is a philosopher' is a simple proposition as it does not involve a combination of propositions. On the other hand, complex propositions are formed by combining more than one simple proposition. These compound propositions use logical operators to establish relationships between the component propositions.

- logical operators: 'and', 'or', 'if-then'

One type of complex proposition is the conjunctive proposition, which combines multiple propositions using the logical operator 'and'. The compound conjunctive proposition is considered true only if all component propositions are true. For instance, the proposition 'Meera is intelligent and Jeeva is hardworking' is a conjunctive proposition and the proposition can be true only if both sides/components of the conjunctive proposition are true. Another type of compound proposition is the disjunctive proposition, which combines multiple propositions using the logical operator 'or'. The compound disjunctive proposition is considered true if at least one of the component propositions is true, such as 'I like either tea or coffee'. Another kind of compound proposition is the hypothetical or implicative proposition, which combines two propositions and expresses a relationship between them using the logical operator 'if-then'. These propositions consist of an antecedent (the 'if' part) and a consequent (the 'then' part). For instance, the statement 'If you study well, then you will pass the exam' is a compound hypothetical proposition.

According to the relation of terms, propositions are classified into three types:

1. Categorical Proposition
2. Hypothetical Proposition
3. Disjunctive Proposition

1.3.1.1 Categorical Proposition

- Categorical proposition stated as without any conditions

A categorical proposition establishes a relation between two terms using a copula. The predicate in a categorical proposition is either assigned or denied to the subject without any conditions. They are unconditional propositions like 'all crows are black.'

1.3.1.2 Hypothetical Proposition

- Hypothetical proposition involves a condition

The hypothetical proposition is a compound proposition, in which the condition is introduced by the conjunction 'if' or any other word equivalent to it. A hypothetical proposition involves an antecedent and a consequent part and expresses a conditional relationship between the antecedent and the consequent. In this type of proposition, when the antecedent is true and the consequent is false; then the proposition is false.

For example, 'if it rains, the game will be postponed'.

Here, the antecedent part is, 'if it rains' and the consequent is 'the game will be postponed'.

1.3.1.3 Disjunctive Proposition

- Disjunctive proposition has two alternatives

The distinctive proposition, a form of a compound proposition, is one which enumerates two alternatives. Any one of which may belong to the subject. Disjunctive propositions present alternatives or options without asserting the truth of any specific component proposition. They are typically expressed using the logical operator 'either...or'. It states that if at least one of the component propositions is true, then the proposition is also true. For example, 'Sheela is either a day scholar or a hosteller'.

1.3.2 Categorical Proposition Based on Quantity and Quality

In traditional logic, categorical propositions were the focus of study, particularly before the nineteenth century. Aristotle, the ancient Greek philosopher, was the first to formalise logic and identify different types of categorical propositions. His work on syllogistic logic, which uses subject-predicate statements in a syllogism, laid the foundation for categorical logic, also known as Aristotelian logic or the logic of the categorical syllogism.

- Quantity of a proposition indicates the generalisation of the subject

Categorical propositions are statements that divide the world into two distinct classes and make assertions about the members of those classes. They consist of a subject term, a copula (connecting verb), and a predicate term. The quantity and quality of a categorical proposition determine its nature and meaning. Understanding the quantity and quality is essential for evaluating their validity and drawing inferences. The

quantity of a proposition indicates the generalisation of the subject term. This generalisation may be restricted or unrestricted, giving rise to two types of quantities: universal and particular.

In a universal proposition, the subject denotes the whole class and indicates unrestricted generalisation. For example, in the proposition 'All men are mortal', the subject term 'All men' refers to the entire class. Similarly, in the proposition 'No crows are mammals', the subject term refers to the entire class of crows, which is excluded from the whole class of mammals. Hence, the quantity in these propositions is universal. On the other hand, in a particular proposition, the subject depicts restricted generalisation. For instance, in the proposition 'Some flowers are red', the quantity mentioned is a particular class, such as 'some flowers' from the universal term 'all flowers'. The subject of this proposition indicates only a part of a class. Similarly, in the proposition 'Some students are not hardworking', the quantity is also particular.

- Universal propositions have an unrestricted generalisation

The quality of a proposition indicates the relationship between the predicate and the subject. It shows whether the predicate is affirmed or denied with respect to the subject, leading to two types of qualities: affirmative and negative. If a predicate is affirmed to the subject, the proposition's quality is affirmative. For example, in the proposition 'All men are mortal', the quality 'mortal' is affirmed for the subject class 'man'. If a predicate is denied from the subject, the quality of the proposition is negative. For instance, consider the proposition 'Some people are not hard working', where the predicate term 'hard working' is denied by the class of some people. Hence, the proposition is negative.

- Quality indicates the relationship between the predicate and the subject

Categorical propositions can be categorised into four types based on the possible combinations of quantity and quality. They are:

1. Universal Affirmative (A proposition)
2. Universal Negative (E proposition)
3. Particular Affirmative (I proposition)
4. Particular Negative (O proposition)

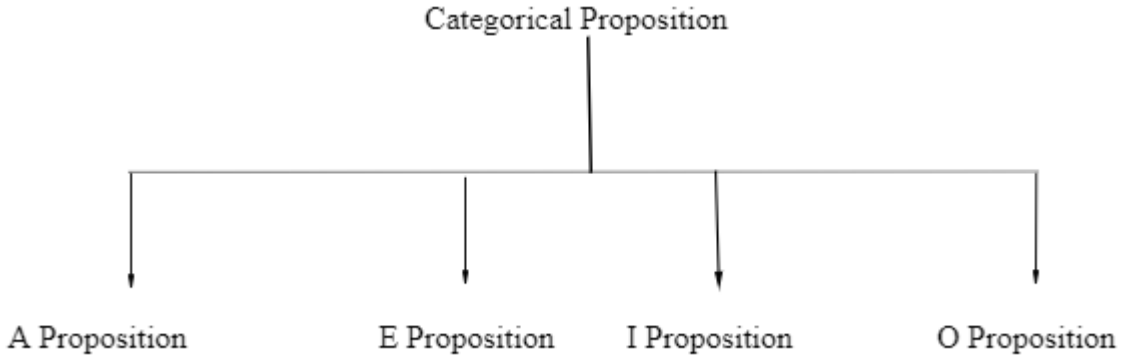


Fig 1.3.1 Classification of Categorical Proposition

1.3.2.1 Universal Affirmative Propositions (A Proposition)

- In 'A' proposition, quantity is universal and quality is affirmative

These propositions assert that the whole of one class is included in another class. For example, the statement 'All bats are mammals' affirms that every bat belongs to the class of mammals. Here, the quantity is universal, and the quality is affirmative. Universal affirmative propositions can be written as 'All S is P', where S represents the subject term and P represents the predicate term.

1.3.2.2 Universal Negative Propositions (E Proposition)

- In 'E' proposition, quantity is universal and quality is negative

Universal negative propositions deny the inclusion of any member of the subject class in the predicate class. For instance, the statement 'No men are immortal' universally denies the membership of men in the class of immortality. Here, the quantity is universal, and the quality is negative. These propositions can be written as 'No S is P', indicating that no members of S belong to P.

1.3.2.3 Particular Affirmative Propositions (I Proposition)

- In 'I' proposition, quantity is particular and quality is affirmative

Particular affirmative propositions affirm that at least one member of the subject class is also a member of the predicate class. They do not make universal claims about the entire subject class. Here, the quantity is particular, and the quality is affirmative. For example, the statement 'Some birds can fly' asserts that there are birds that can fly without specifying the total number. These propositions can be written as 'Some S is P', which means some members of S belong to P.

1.3.2.4 Particular Negative Propositions (O Proposition)

- In 'O' proposition, quantity is particular and quality is negative

Particular negative propositions assert that at least one member of the subject class is excluded from the predicate class. They deny the inclusion of some members of the subject class in the predicate class. Here, the quantity is particular, and the quality is negative. An example is the statement 'Some flowers are not fragrant'. The quality of 'fragrant' is denied to a certain class of flowers. These propositions can be written as 'Some S is not P', indicating that some members of S do not belong to P.

In traditional logic, singular propositions, which refer to specific persons or objects, are to be considered as universal propositions. For example, statements like 'Sreenarayanaguru was a great social reformer', 'Dr B. R. Ambedkar was a famous political leader,' and 'Thiruvananthapuram is the capital of Kerala' are treated as universal propositions because they represent a class or unit class (a class with only one member). The quantity of a categorical proposition is determined by the quantifier used, such as 'all' or 'some'. 'All' indicates a universal quantity, while 'some' implies a particular quantity. The quality of a proposition is determined by whether it affirms or denies the overlap between the subject and predicate classes. Affirmative propositions assert an overlap, while negative propositions deny it.

1.3.3 Distribution of Terms

A term is considered distributed when it encompasses all the members of a class. Conversely, a term is regarded as undistributed if it only accounts for a portion of the class's denotation. Each term in a categorical proposition can be either distributed or undistributed. A term is considered distributed if the subject of the proposition refers to the entire class. On the other hand, a term is undistributed if the proposition does not refer to the entire class named by that term.

The four types of categorical propositions (A, E, I, O) and their distribution of terms are as follows. In A-type propositions, which are universal affirmatives, the subject term is distributed while the predicate term is undistributed. For example, consider the statement 'All parrots are green'. Here, the subject term 'Parrot' refers to the entire class (distributed), while the predicate term 'green' refers only to a part of the class (undis-

tributed). This is because there are many things that are green in colour other than parrots. The Venn diagram of 'A' proposition is as follows. Here, 'A' proposition asserts that all members of S are also members of P. To represent this visually, shade out the portion of S that is not part of P, indicating that there are no members of S that are not also members of P. In simple terms, 'A' proposition simply states that everything in S is also in P.

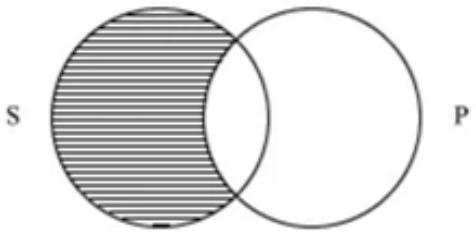


Fig 1.3.2 Venn diagram of the categorical proposition "All S are P"

In E-type propositions, which are universal negatives, both the subject and predicate terms are distributed. Take the example 'No parrots are cold-blooded.' In this case, the subject term 'parrots' refers to the entire class (distributed), and the predicate term 'cold-blooded' also refers to the entire class (distributed). Here, the entire class of parrots is excluded from the entire class of cold-blooded. Both the subject term and the predicate term are distributed here. The Venn diagram of 'E' proposition is as follows. 'E' proposition illustrates mutual exclusion between the categories S and P by shading out the overlapping portion of their circles in the diagram. This shading indicates that there are no common members between S and P. In simpler terms, 'E' proposition states that there are no elements that belong to both S and P at the same time.

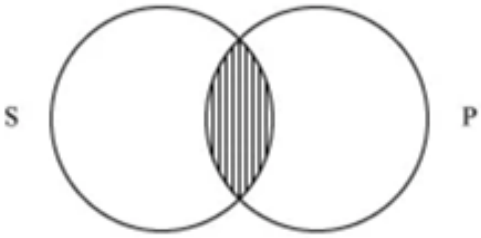


Fig 1.3.3 Venn diagram of the categorical proposition "No S are P"

In I-type propositions, which are particular affirmatives, both the subject and predicate terms are undistributed.

Consider the statement 'Some rabbits are in grey colour.' Here, the subject term 'rabbit' refers only to some members of the class (undistributed), and the predicate term 'grey colour' also refers only to some members of the class (undistributed). This is because there are many things that exist which are grey in colour. But here, it indicates only the colour of some rabbits. The Venn diagram of 'I' proposition is as follows. 'I' proposition is represented in the diagram by placing an 'X' in the region where the circles representing S and P overlap. This indicates that there is at least one member that belongs to both S and P. In simpler terms, 'I' proposition asserts that there is a common element between S and P.

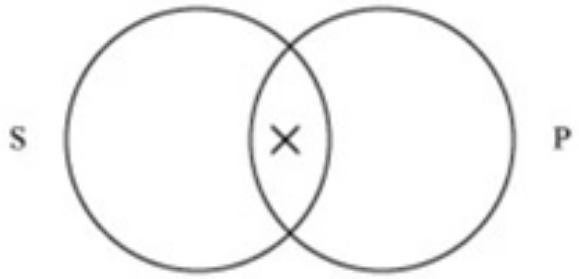


Fig 1.3.4 Venn Diagram of the categorical proposition "Some S are P".

Lastly, in O-type propositions, which are particular negatives, the subject term is undistributed while the predicate term is distributed. For instance, in the statement 'Some dogs are not hunters,' the subject term 'dogs' refers only to some members of the class (undistributed), while the predicate term 'hunters' refers to the entire class (distributed). The Venn diagram of 'O' Proposition is as follows. 'O' proposition is visually represented in the diagram by placing an 'X' in the region of S that is outside of P. This indicates that there is at least one member of S that does not belong to P. In simpler terms, the O proposition states that there is an element in S that is not part of P.

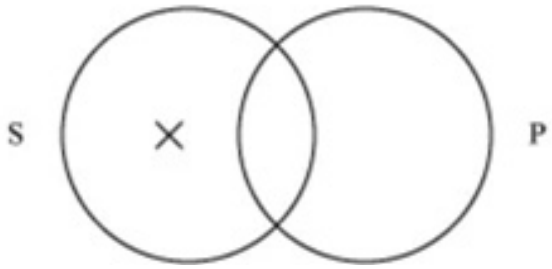


Fig 1.3.5 Venn Diagram of the categorical proposition "Some S are not P"

Understanding the distribution of terms is crucial for evaluating the validity of categorical syllogisms. It helps us determine the relationship between the subject and predicate classes and whether the proposition makes claims about the entire classes or only certain members. It is interesting to note that the terms A, E, I, and O are derived from Latin words. 'A' and 'I' are derived from 'affirmo', meaning 'I affirm', while 'E' and 'O' are derived from 'nego', meaning 'I deny'. These letters were chosen to represent the affirmative and negative qualities of the categorical propositions. To further explore the concept of distribution of terms, one can understand the connection between term distribution and proposition quantity (universal or particular) and examine the consistent pattern followed by the four types of categorical propositions (A, E, I, O).

Table 1.3.1 Table Representing Distribution of Terms

Type of Proposition	Proposition	Quantity	Quality	Subject Term	Predicate Term
A Proposition	All S is P	Universal	Affirmative	Distributed	Undistributed
E Proposition	No S is P	Universal	Negative	Distributed	Distributed
I Proposition	Some S is P	Particular	Affirmative	Undistributed	Undistributed
O Proposition	Some S is not P	Particular	Negative	Undistributed	Distributed

1.3.4 Euler's Circle

Euler's circles are diagrams that show how different sets of categorical propositions relate to each other. They are similar to Venn diagrams but focus on the relevant relationships. They are named after the Swiss mathematician Leonhard Euler, who pioneered their use in the 18th century. Euler's circles use closed curves or circles to represent sets or categories. The circles are labelled with the names of the sets they represent. The overlapping or non-overlapping areas of the circles illustrate the relationships between the sets. Sets with no common elements are shown with non-overlapping curves or shapes. Sets that share common elements are shown with overlapping curves. Venn diagrams are more rigid compared to Euler's circles because they must show all possible combinations of overlap between the curves. Here,

- The circle inside the other indicates the inclusion of one class within the other.
- Two circles which are drawn entirely outside each other

indicate the mutual exclusion of two classes.

- Two overlapping circles represent either an indefinite partial inclusion or an indefinite partial exclusion.

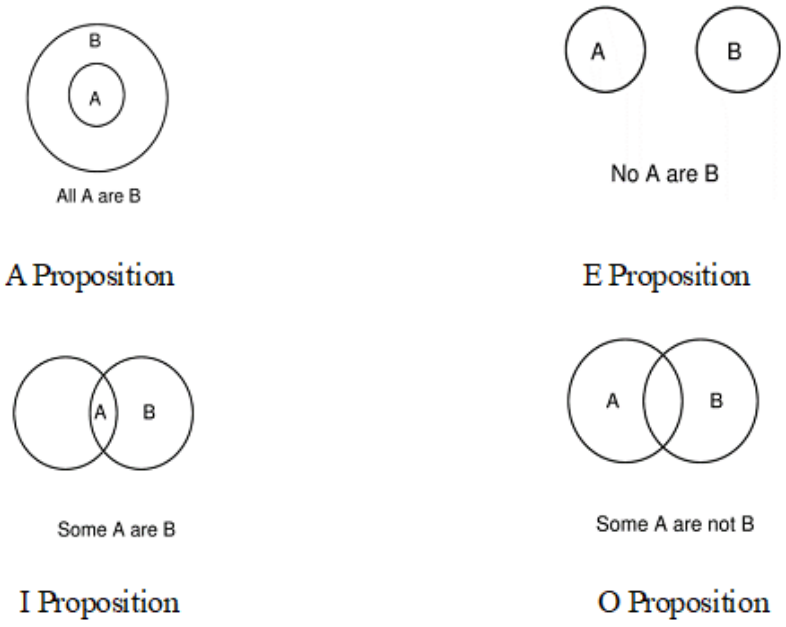


Fig 1.3.6 Euler's Circle of Categorical Propositions

1.3.5 Reduction of Sentences to Logical Form

Formal logic recognizes only four kinds of propositions: A, E, I, and O. The sentences that do not fall into these categories need to be reduced to one of these four forms before they can be considered in logic. This is done to avoid confusion in reasoning. Sometimes, the reduction process may result in awkward and jarring language. However, logic prioritises truth above all else.

When converting sentences to propositional form, it is essential to keep in mind the following guidelines: First, ensure that the meaning of the original sentence is preserved accurately in the logical form. Then, express all three parts of the proposition in the correct order: subject, copula, and predicate. To determine the subject, ask the question, 'What is being spoken of?' For the predicate, ask, 'What is being stated about the subject?' Use a suitable copula, such as 'is', 'is not', 'are', 'are not', or 'am' to connect the subject and predicate effec-

tively. When dealing with negative sentences, place the negation with the copula and not with the predicate. For example, if the sentence 'Some employees did not work hard' is being transformed, it should be written as 'Some employees/ are not/ persons who work hard' rather than 'Some employees/ are persons/ who did not work hard'.

Compound sentences should be divided into simple propositions. Each simple proposition should have only one subject, one predicate, and a copula. For instance, if the sentence is 'Hard work and intelligence are essential for success', it should be split into 'Hard work is essential for success' and 'Intelligence is essential for success'. Lastly, ensure that the quantity and quality of the proposition are indicated clearly. This helps to convey the scope and nature of the statement effectively.

Here are some methods to determine the quantity and quality of a proposition:

- Sentences with words like 'all, every, each, any, he, who, whoever, the, a, always' in the subject become SAP (universal affirmative propositions), while sentences with words like 'no, none, never, nothing, nobody, not one' become SEP (universal negative propositions).
- Sentences with words like 'most, a few, certain, many, several, almost all, all but one, nearly all, a small number, the majority, frequently, generally, often, perhaps, mostly, sometimes, nearly always' become SIP (particular affirmative propositions).
- Sentences containing the negation 'not' and words like 'all, every, any, he, who, whoever, the, a, always' become SOP (particular negative propositions), as do sentences with words like 'few, scarcely, hardly, seldom.'
- Exclusive sentences have a predicate that is denied or not applied to all individuals except those indicated by the subject term. They can be reduced to 'E' (universal negative) or 'A' (universal affirmative) form by interchanging the subject and predicate.

- Exceptive sentences affirm the predicate of the whole subject except for a portion indicated by words like 'except, all but,' etc. They can be reduced to universal or particular propositions based on the specificity of the exceptions.
- Singular propositions with a definite individual or collection of individuals as the subject are reduced to universal propositions, while indefinite singular terms without a definite reference are treated as particular propositions.
- Indefinite or indesignate propositions have a vague subject quantity. They are considered universal if the attribute is invariable and common, and particular if the attribute is accidental.
- Opative sentences are reduced based on their meaning. May God bless you = SAP.
- Exclamations can be easily reduced to logical form, and inverted sentences should be rearranged to determine their logical form.

Summarized Overview

In logic, the inference is based on affirming or denying a proposition based on one or more accepted propositions as the starting point. The logician carefully examines the initial and final propositions of an argument, as well as the relationships between them, in order to determine the correctness of the inference. This emphasises the fundamental importance of propositions in the field of logic, as they serve as the building blocks upon which logical reasoning is constructed. Propositions are distinct from sentences in that they have truth values, allowing them to be affirmed or denied as true or false, while sentences lack this inherent truth value. The grammatical correctness or incorrectness of a sentence is determined by linguistic rules. However, the truth or falsehood of a proposition is contingent upon empirical facts and the correspondence between the proposition and the state of affairs it refers to. Therefore, propositions assume a deeper level of significance as units of meaning, implication, and logical reasoning to bridge the gap between language and reality.

Self-Assessment

1. Explore and elucidate the diverse categories of sentences.
2. What is a proposition? detailing the various types based on their quality and quantity.
3. Provide insights into the three categories of compound propositions utilizing logical operators.
4. Break down the concepts of conditional and categorical propositions with examples.
5. Define and distinguish between the quantity and quality of a categorical proposition.
6. Explain the concept of term distribution within categorical propositions.
7. Explain the difference between a universal affirmative proposition and a particular negative proposition.

Assignments

1. Explain the distinctions among declarative sentences, interrogative sentences, imperative sentences, and exclamatory sentences. Provide an example for each type to illustrate their unique characteristics.
2. Explore the concept of the distribution of terms in categorical propositions. Explain why it is important to understand term distribution and how it impacts the validity and meaning of categorical syllogisms. Provide examples to illustrate the same.
3. Describe the concept of Euler's circle and visually represent the relationships between two categorical propositions. Provide an example of how Euler's circle can be used to represent propositions

Reference

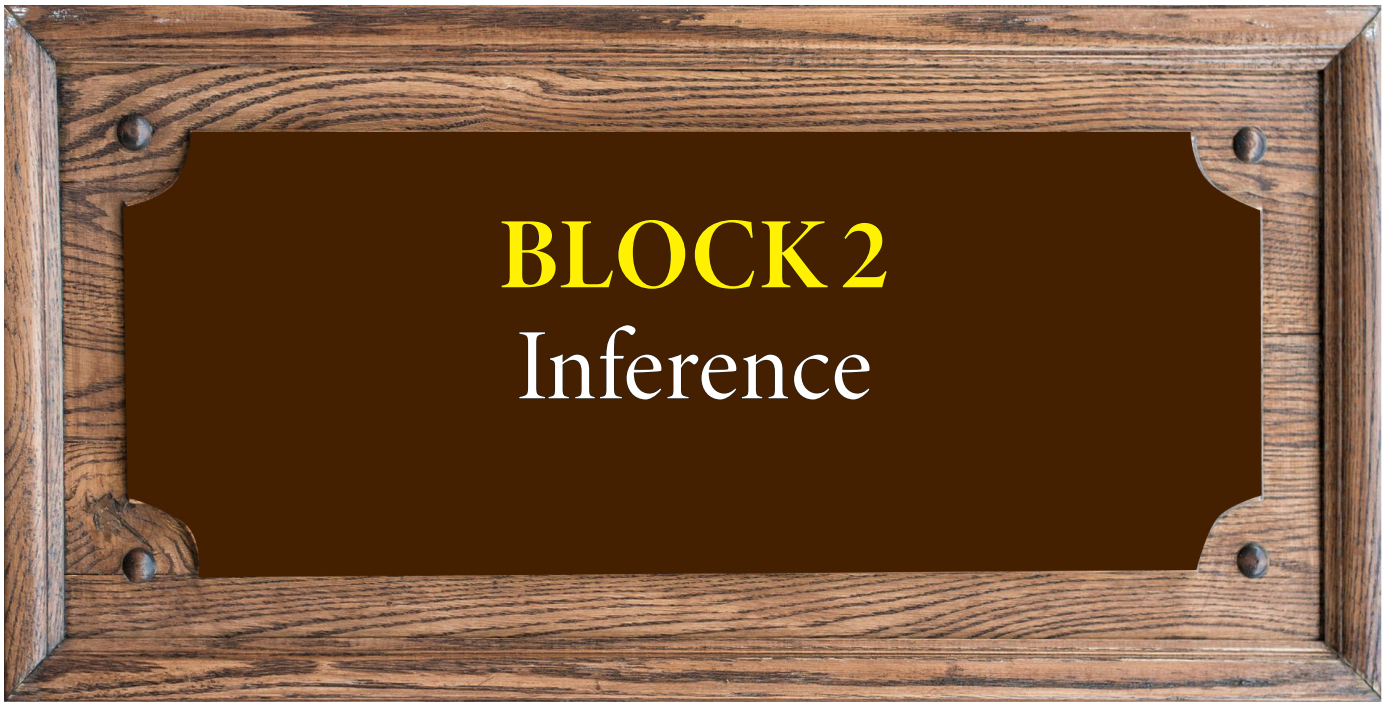
- Bowie, G. (2004). *A Beginner's Guide to Logic*. Oxford University Press.
- Creighton, J. E., & Smart, J. J. C. (1973). *An Introduction to Logic* (2nd ed.). Routledge.

Suggested Reading

- Copi, I. M., & Cohen, C. (2017). *Introduction to Logic* (15th ed.). Routledge.
- Hurley, P. J. (2014). *A Concise Introduction to Logic* (12th ed.). Cengage Learning.
- Smith, H. (2013). *An Introduction to Formal Logic* (3rd ed.). Cambridge University Press.

Space for Learner Engagement for Objective Questions

Learners are encouraged to develop objective questions based on the content in the paragraph as a sign of their comprehension of the content. The Learners may reflect on the recap bullets and relate their understanding with the narrative in order to frame objective questions from the given text. The University expects that 1 - 2 questions are developed for each paragraph. The space given below can be used for listing the questions.


BLOCK 2
Inference

UNIT 1
Argument

Learning Outcomes

After the completion of this unit, the learner will be able to:

- understand the process of inference and its role in deriving conclusions from given arguments
- differentiate between deductive and inductive inferences and recognize their applications and limitations
- analyse and evaluate the logical connections between premises and conclusions in various types of inferences
- develop critical thinking skills to assess the strength and validity of different inferences

Background

Inference is a fundamental concept in logic and critical thinking which enables us to go beyond direct evidence and draw upon our knowledge. Throughout history, inference has been essential for problem-solving and understanding complex situations. From ancient Greek philosophers like Aristotle to modern scholars, inference has contributed to fields like mathematics, science, and philosophy. Today, it plays a vital role in academic disciplines, helping researchers form hypotheses and draw conclusions. Understanding inference is crucial not only for academics but also for everyday life, as it enhances decision-making, communication, and problem-solving skills. Making valid inferences and constructing sound arguments empower individuals to analyse information critically and engage in meaningful discussions.

Keywords

Inference, Argument, Deduction, Induction, Truth and Validity

Discussion

2.1.1 Inference

- Inference is the process of drawing a conclusion

Inference is the process of finding out something new from what we already know. It helps us understand things that are not directly obvious to our senses. It is at the centre of logical arguments, and it is upon which we expand our realm of knowledge. When we infer, we start with things that we already know, called 'premises,' and by using logical thinking, we reach new conclusions. The evidence provided to substantiate the conclusion is said to be premises and that which is drawn on the basis of the premises is the conclusion. The intellect draws conclusions based on previous judgments derived from our senses. For example, when we see the ground as wet, we can infer that it rained. Here, by using our past knowledge and observations, we infer that it rained. In ancient Greece, the philosopher Aristotle explained the inference by using 'syllogism.' The syllogism consists of three propositions, where the conclusion is derived from the preceding premises. According to the Dictionary of Philosophy, inference refers to 'the drawing of a conclusion' and is also known as reasoning. Thomas Aquinas states that reasoning is the act of advancing from one known thing to another unknown thing.

- Arguments represent the inference

In propositional logic, the propositions leading to a new truth are called the antecedent which provides reasons to assert the new truth. The proposition expressing the new truth is known as the consequent, which necessarily follows from the antecedent. Through this form of inference, we can achieve certainty in our knowledge. Inference is closely related to reasoning, which is the process of using our intellect to understand things. Thus, inference and reasoning are often used interchangeably. But it is important to note that inference itself is not an argument. Inference is the psychological process of moving from one thought to another, whereas argument is

constructed to represent the inference. Inferences play a crucial role in better understanding the world around us. While evidence and proof are significant, they have limitations, and there are situations where the available evidence may not provide a complete answer. In such cases, inference allows us to go beyond the limitations of evidence and draw conclusions through logical reasoning.

- Inference is the building block of reasoning

Inferences are necessary for making sense of the information we encounter and comprehending the world in a meaningful way. The process of making good inferences involves careful analysis and consideration of the available evidence. It requires evaluating the relevance and reliability of the evidence to draw logical and valid conclusions. Inferences form the building blocks of arguments, as every argument is based on a series of inferences that connect the evidence to the ultimate conclusion. Developing strong inference-making skills enhances our ability to critically analyse information, understand complex ideas, and construct well-supported arguments.

- Inferences are essential for evaluating the validity of arguments

By enhancing our inference-making skills, we enhance our overall reasoning abilities and become better equipped to seek deeper knowledge, engage in meaningful discussions, and participate in logical debates. Inferences are essential for evaluating the validity of arguments and ensuring logical coherence. Understanding the role and significance of inferences allows us to navigate the complexities of reasoning and to promote a more comprehensive understanding of the world around us.

2.1.2 Argument

- Argument serves as the foundation for evaluating complex concepts

The argument plays a crucial role in logical thinking and critical analysis. The primary way we reason is through the use of arguments. Hence, it is necessary to understand what an argument is in order to develop a theory of good reasoning. Arguments serve as the foundation for evaluating and understanding complex concepts and ideas. Reasoning takes various forms in everyday speech, writing, and thought. To have better discussions about reasoning, it is helpful to have a standard way to represent ordinary reasoning. This is where the notion of an argument becomes significant.

In logic, an argument consists of a sequence of propositions. It is a complex symbolic structure that includes premises and a conclusion. The premises provide support for the con-

clusion. An argument can be seen as a speech act that includes premises, a conclusion, and a marker indicating the logical connection between them. The premises guarantee or make the conclusion. At times, they make the conclusion more probable or imply it, or make it more acceptable. The conclusion represents the claim that the reasoner aims to establish something to be true through the process of reasoning, while the premises serve as the foundation for supporting the conclusion. Both premises and conclusions are statements, which are sentences that can be true or false. Statements are sentences about which it makes sense to ask whether they are true or false. Explanations, questions and commands cannot be part of arguments as they do not have truth value. Any sequence of one or more propositions can be considered as an argument. This inclusive approach ensures that our account of validity can be applied to a wide range of reasoning, including various types of arguments that may not align with our conventional understanding. Arguments consist entirely of statements which are either true or false.

- Arguments consist of premises and conclusions

There are several formats for representing arguments. One common format involves listing the premises followed by the conclusion, with a horizontal line used to separate them.

Premise 1

Premise 2

...

Premise n

Conclusion

Another format uses the term 'Therefore' (∴) to indicate the conclusion. Additionally, arguments can be presented in a linear fashion, with the premises separated by commas and the conclusion separated by a slash and the word 'therefore'. When analyzing a piece of reasoning expressed in ordinary language, it is crucial to identify the conclusion and premises. The conclusion represents the proposition that the speaker or reasoner is attempting to establish or provide reasons for, while the premises are the propositions presented as support or evidence for the conclusion. Common indicators for conclusions include phrases such as 'therefore', 'hence', 'thus', 'so', and 'it follows that'. However, it is important to note that these indicators may not always be present or directly correspond to conclusions and premises, and thus careful analysis is necessary.

- 'Therefore' (∴) is the common indicator of the conclusion

- Validity determines the strength of an argument

In elementary logic, two sets of evaluative notions are generally used: true/false and valid/invalid. A proposition is either true or false. When a proposition gives correct information, it is true and when it gives incorrect information, the proposition is false. 'All human beings are mortal' is a true proposition, while 'All men are literate' is false. A deductive argument is evaluated as either valid or invalid. Validity is a key concept in determining the strength and soundness of an argument. An argument is valid if its premises necessarily imply the conclusion. By representing reasoning as an argument, we can systematically examine the logical connections between the premises and the conclusion. This analysis helps us assess the validity of the argument and determine if the conclusion logically follows from the given premises. Developing an understanding of arguments and their components enhances our critical thinking skills and our ability to construct well-reasoned arguments.

The main classification of arguments or inference is;
1. Deductive Argument
2. Inductive Argument

Traditionally, inference is classified as follows

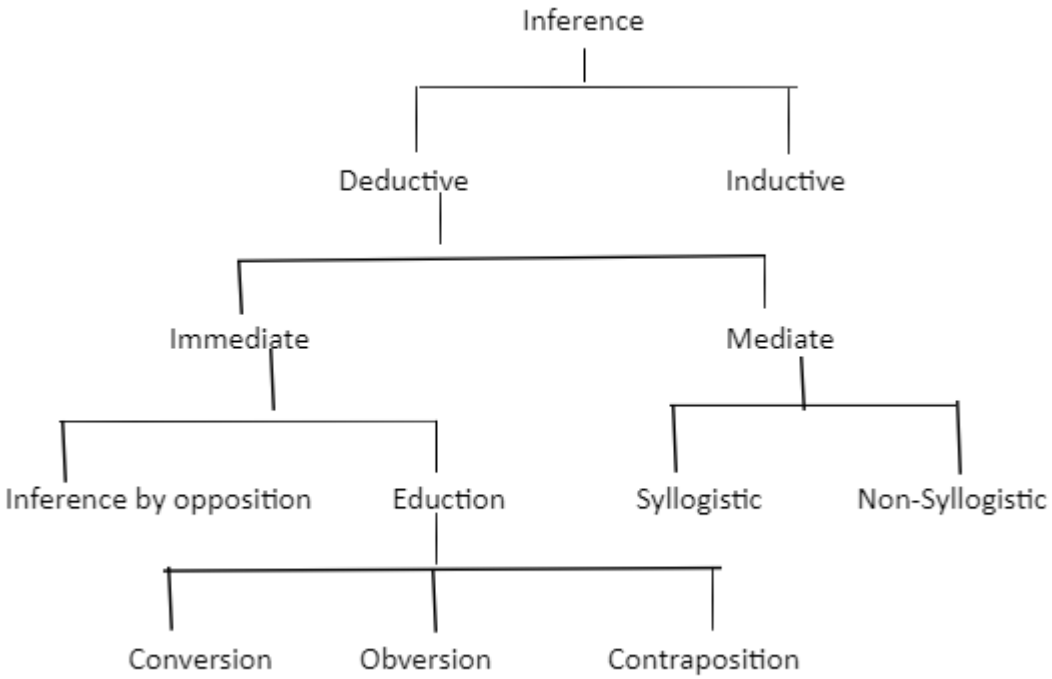


Fig 2.1.1 Classification of Inference

2.1.2.1 Deductive Argument

- In deduction, particular conclusions are drawn from general premises

Deduction is a kind of powerful and fundamental form of argument or logical thinking. It is often referred to as deductive reasoning or deductive logic, which lies at the core of numerous academic disciplines, including mathematics, philosophy, and the sciences. Deduction is the systematic and rigorous method of reasoning that allows us to draw particular or certain conclusions from general principles or premises. Deduction provides a compelling and logical way to draw particular conclusions. It is characterised by the use of structured arguments, where the truth of the premises guarantees the truth of the conclusion.

- Premises serve as the evidence to draw the conclusion

Deductive inference involves the process of deriving less general propositions as conclusions from more general premises. It comprises two essential components: premises and a conclusion. The premises are propositions that serve as evidence, while the conclusion is the logical consequence drawn from these premises. It is fundamentally based on the principle of necessity, where the conclusion is claimed to necessarily follow from the given premises, without any space for doubt or uncertainty. This necessity is absolute and does not depend on any additional information beyond the premises themselves. The validity of a deductive argument lies in the logical relationship between the premises and the conclusion. An argument is valid if the conclusion necessarily follows from the premises, ensuring that if the premises are true, the conclusion must also be true.

All human beings are mortal } Universal Premise

Sruthi is a human being

.....

Therefore, Sruthi is mortal } Particular Conclusion

- A deductive argument is sound when it has valid and true premises

Valid deductive arguments have true or false premises and a true or false conclusion. However, when a deductive argument is both valid and has true premises, it is considered to be a sound argument. Sound arguments are reliable and provide a solid basis for accepting the conclusion as true. Sound deductive arguments can be regarded as tautologies, as their conclusions remain true under all conditions, given the truth

of the premises. Deductive arguments can often be represented by symbolically using formal logic notations. Logical connectives, such as '.' (and), '∨' (or), '⊃' (implies), and '~' (not), express the logical relationships between propositions. This symbolic representation enables precise analysis and evaluation of deductive arguments, making it an invaluable tool in logical reasoning. It provides a concise and unambiguous way to articulate complex logical relationships.

In mathematics, proofs rely heavily on deductive reasoning to establish the validity of theorems and mathematical statements. The certainty provided by deductive logic is particularly vital in this field, where mathematical truths are derived with absolute precision. Similarly, in the sciences, deductive reasoning is used to make predictions based on existing theories and laws. When experimental results align with these predictions, it provides strong evidence supporting the validity of the underlying scientific principles. While deduction is a powerful tool, it is highly dependent on the accuracy and truthfulness of the premises. If the premises are false or poorly chosen, the conclusion may be incorrect, even if the argument is valid. As we already said, deductive reasoning is not suitable for generating new knowledge; it can only draw conclusions from existing premises.

- Deduction does not help to generate new knowledge

The deduction is limited to the information available within the premises, and as such, it may not be well-suited to addressing complex and open-ended problems. Despite its limitations, deductive reasoning plays a crucial role in various real-world applications. In fields such as law, deductive reasoning is used to construct persuasive arguments, where the conclusion is derived with certainty from the presented evidence. In computer science and artificial intelligence, deductive reasoning forms the foundation of algorithms that allow machines to reach precise and unambiguous conclusions based on given data and rules. Moreover, in everyday decision-making, people often employ elements of deductive reasoning to draw logical conclusions from available information.

- Deduction is limited to the premises and does not add new knowledge

2.1.2.2 Inductive Argument

- Induction is the process of drawing a general conclusion from particular premises

Induction is a process of drawing general conclusions from specific or particular observations or premises. It is an ascending process here as we go from particular premises to universal conclusions. In an inductive argument, the conclusion

is not claimed to be conclusively supported by the premises. Instead, the conclusion is considered probable or likely based on the available evidence. The strength of an inductive argument depends on the quality and quantity of the evidence. The more instances that support the generalisation, the stronger the inductive argument becomes. The inductive argument is based on the idea that regularities can be observed in specific instances and are likely to hold true for a broader set of cases. Unlike deduction, which aims for certainty, induction provides probable support for its conclusions.

A is a human and is mortal
B is a human and is mortal
C is a human and is mortal
} Particular Premises

Therefore, all humans are mortal } Universal Conclusion

- Induction helps in scientific developments

In scientific investigations, researchers often use inductive methods to formulate hypotheses and make conclusions based on observed patterns. By collecting data from a representative sample, scientists can draw broader conclusions about the entire phenomenon they are studying. After conducting multiple experiments and observing consistent results, scientists may infer a general law or principle. For instance, when scientists observe many particular instances of combining hydrogen and oxygen to give water, they draw a general conclusion or law that hydrogen and oxygen give water (H2O).

- Strength of induction depends on the quality and quantity of premises

In our daily lives, we frequently use inductive reasoning to make judgments and decisions. In historical and sociological studies, inductive reasoning plays a significant role. Historians draw conclusions about past events based on available records and artefacts. Sociologists make inferences about larger social groups from the data collected through surveys and research. A strong inductive argument presents multiple instances supporting the generalisation, making the conclusion more likely to be true. Conversely, a weak inductive argument lacks sufficient evidence, reducing its persuasiveness.

Inductive reasoning does not guarantee absolute truth; new evidence or observations could lead to different conclusions. In an inductive argument, the premises do not provide a conclusive ground for the conclusion, rather, provide some sup-

port for the conclusion. However, it is a valuable tool for making informed judgments and predictions based on available information. The 'problem of induction' highlighted by philosopher David Hume reminds us of the uncertainty involved in the inductive argument. He asks how can we jump from a few particular cases to a universal conclusion. For example, after having observed that 'X' and 'Y' crows are black, Hume asks, how can we draw a universal conclusion that 'All crows are black'. However, induction remains valuable for making informed judgments and predictions based on available information.

- Induction does not guarantee absolute truth

2.1.3 Truth and Validity

Truth and validity are fundamental concepts that play an important role in assessing the strength of arguments. They are distinct, but interconnected aspects that help us to determine the reliability of an argument and the truthfulness of its conclusions.

Truth relates to individual propositions or statements and relies on the correspondence between a proposition and the actual state of affairs in the world. When a statement accurately describes reality, it is considered to be true. For instance, the statement that 'the earth rotates around the sun' corresponds to the observed phenomenon and is therefore considered to be true. On the other hand, if a statement does not accurately reflect reality, it is false. The statement 'All cats are birds', is false because it contradicts the observable facts about cats. Truth is an attribute of individual propositions and is independent of any argument. Truth evaluates the accuracy of individual statements; and depends on the correspondence of individual propositions to reality. It is impossible for the premises to be true while the conclusion is false. However, truth alone does not guarantee the soundness of an argument. A single true premise or conclusion does not necessarily make the entire argument valid or reliable. An argument can contain true premises and still lead to a false conclusion, or vice versa.

- A statement is true when it describes reality

The validity, on the other hand, belongs to the logical relationship between the premises and the conclusion within an argument. Validity examines the coherence and consistency of the logical structure of the argument. An argument is valid when the conclusion logically follows from the premises. In a valid argument, the conclusion is a necessary consequence of

- Validity is the logical relationship between the premises and the conclusion

the given premises. To assess the validity of an argument, we focus on the structure of reasoning, not on the truth or falsehood of individual statements. A valid argument can have all false premises and still can result in a true conclusion. An invalid argument can have all true premises and still yield a false conclusion. Invalid arguments do not logically follow from the premises.

- Valid argument with true premises always gives a true conclusion

Truth and validity assess different aspects of arguments. A conclusion can be true, if it logically follows from true premises, and it can also be true if it accidentally aligns with reality despite having false premises. It is important to recognize that, a valid argument with true premises generally leads to a true conclusion, while a valid argument with false premises can lead to either a true or false conclusion. Truth and validity serve different roles in the evaluation of statements and arguments. Understanding the concept of truth and validity for analysing and constructing sound logical arguments and making informed judgements about the reliability of information and reasoning.

Let us consider a few examples:

1. Some valid arguments have only true propositions; both true premises and a true conclusion:

All roses are flowers. (True premise)
All flowers have petals. (True premise)

Therefore, all roses have petals.
(True Conclusion)

} Valid Argument

2. Some valid arguments have only false propositions; both false premises and a false conclusion:

All mammals can swim. (False premise)
All birds are mammals (False premise)

Therefore, all birds can swim.
(False conclusion)

} Valid Argument

This argument is valid, even though all the propositions of this argument are false. Because, if the premises it starts with

were actually true, then the conclusion it derives would have been true as well. However, both the premises and the derived conclusion of this argument are not true in reality, but false.

3. Some invalid arguments contain only true premises and have a false conclusion.

If Sreenarayanaguru is a businessman, he will be famous. (True premise)

Sreenarayanaguru is not a businessman. (True premise)

Therefore, Sreenarayanaguru is not famous. (False Conclusion)

} Invalid Argument

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.

4. Some valid arguments have false premises and a true conclusion:

All animals can swim. (False premise)
All penguins are animals. (False premise)

Therefore, all penguins can swim. (True conclusion)

} Valid Argument

The conclusion of this argument is true; moreover, it can be validly inferred from these two premises; but both premises are false.

5. Some invalid arguments also have false premises and a true conclusion:

All mammals are carnivorous. (False premise)

All cows are carnivorous. (False premise)

Therefore, all cows are mammals. (True conclusion)

} Invalid Argument

6. Some invalid arguments have all false propositions; both false premises and a false conclusion:

All mammals are carnivorous.
(False premise)
All cows are carnivorous (False premise) } Invalid Argument

Therefore, all mammals are cows
(False conclusion)

- Truth and falsity of a conclusion do not determine the validity and invalidity of the argument

These examples show that an argument can be valid even if it has a false conclusion, and an argument can be invalid even if it has a true conclusion. So, whether the conclusion is true or false does not tell us whether the argument itself is valid or invalid. The thing is that the validity of an argument does not guarantee the truth of its conclusion. To test the truth or falsehood of premises is the task of science. The logician is not interested in the truth or falsehood of propositions but in the logical forms and the relations between them. By logical relations between propositions, we mean those relations that determine the validity or invalidity of the arguments.

Summarized Overview

Terms combine to form propositions, and create arguments with premises and conclusions. This process of deriving a conclusion from premises is fundamental in logical reasoning and is known as inference. Deductive reasoning involves deriving particular conclusions from general premises, while inductive reasoning draws general conclusions from specific premises. The key distinction between truth and validity is explained, where truth relates to the accuracy of propositions, and validity pertains to the logical relationship between premises and conclusions in an argument. By carefully analysing arguments and assessing their validity, individuals can make informed judgments, construct well-supported arguments, and gain a comprehensive understanding of the world around us.

Self-Assessment

1. Discuss the drawbacks and benefits of inference.
2. What is a deductive and inductive argument? And how do they differ? Explain with an example.
3. How does Induction help in scientific development?
4. Make a note on truth and validity and write the distinction between them.

Assignments

1. Define the term 'argument' and give an example. Why is it important to be able to construct and evaluate arguments? What are the different types of arguments and how do they differ?
2. Explain how scientists use inductive reasoning in their research. Provide an example from a scientific field, outlining the process of drawing general conclusions from specific observations.
3. Explore the 'problem of induction' as highlighted by David Hume. Discuss the challenges and uncertainties associated with inductive reasoning, using examples to illustrate potential issues.

Reference

- Ganeri, J. (2019). "Indian Logic". In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Summer 2019 Edition).
- Lemmon, E. J. (1965). *Beginning Logic*. Nelson.
- Sider, T. (2010). *Logic for Philosophy*. Oxford University Press.
- Copi, Irving M., Carl Cohen, and Kenneth McMahon. *Introduction to Logic.* Fourteenth Edition, Pearson Education Limited, 2014.
- Hurley, Patrick J. Logic: *A Concise Introduction to Logic.* 11th ed., University of San Diego.

Suggested Reading

- Bowie, G. (2004). *A Beginner's Guide to Logic*. Oxford University Press.
- Creighton, J. E., & Smart, J. J. C. (1973). *An Introduction to Logic* (2nd ed.). Routledge.

Space for Learner Engagement for Objective Questions

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UNIT 2
Immediate inference

Learning Outcomes

After the completion of this unit, the learner will be able to:

- acquire a detailed understanding of immediate inference and articulate its significance in reasoning and argumentation
- apply the square of opposition to identify the relationships between the four categorical propositions
- know the different types of immediate inference
- evaluate the validity and soundness of arguments that use immediate inference

Background

Inference refers to the process of drawing a conclusion based on the available evidence or information. Classification of inference is a method of categorising inferences based on various criteria such as the number of premises used, direction of reasoning, and level of certainty of the conclusion. The two main types of inference are deductive inference and inductive inference. The deductive inference is a type of inference in which the conclusion follows necessarily from the premises. In Inductive inference, the conclusion is probable based on the available evidence or information. Hence, an inductive argument is neither true nor false, but only sound or unsound. Immediate inference is a type of deductive inference that involves the transformation of a proposition into an equivalent proposition by changing its quality, quantity, or terms. Understanding the classification of inference is essential in analysing and constructing arguments, identifying fallacies, and developing critical thinking skills. It is also fundamental in formal logic, where immediate inference is used to derive new propositions from existing ones. In this unit, we are going to discuss how the propositions were transformed into equivalent propositions.

Keywords

Conversion, Obversion, Contraposition, Inversion, Eduction, Square of Opposition

Discussion

- Inference is the intellectual process of reasoning

Inference is an intellectual process of reasoning, which derives a proposition as the conclusion from one or more propositions. The inferred proposition is called the conclusion and the given premises are called premises. It is an essential tool in critical thinking and involves evaluating arguments, identifying fallacies, and constructing sound arguments. Inference is used in various fields, including philosophy, science, mathematics, and everyday life.

Inference is divided into two kinds:
1. deduction
2. induction

In Deduction, a particular proposition is derived as a conclusion from general premises

All elephants are mammals

PT-7 is an elephant

∴PT- 7 is a mammal

In Induction, a general proposition is derived as a conclusion from the particular premises.

A is an elephant and is mammal

B is an elephant and is mammal

C is an elephant and is mammal

∴All elephants are mammals

- The term which is distributed in the conclusion must be distributed on the premises

Deductive inference can be divided into two types:

1. immediate inference
2. mediate inference

Every deductive reasoning (immediate or mediate) follows the rule of distribution of terms. The rule states that a term that is distributed in the conclusion, must necessarily be distributed

in the premises. In a deductive argument, the conclusion cannot be wider than the premises. But in induction, the conclusion is equal to or wider than the premises. In the following discussion, we will be discussing in detail the immediate inference.

2.2.1 Immediate Inference

- Immediate inference immediately deduces a conclusion from a single premises

Immediate inference is a type of deductive inference where a conclusion is drawn from a single given premise. The truth and falsity of the conclusion are contained in the truth and falsity of the given proposition or premise. It involves two propositions: one premise and a conclusion. For instance, from the statement 'All men are mortal', we can immediately deduce that 'some men are mortal'. This kind of inference deals with two specific terms only, like 'men' and 'mortal'. There are two types of immediate inference:

1. immediate inference of opposition
2. immediate inference of eduction.

2.2.2 Immediate Inference of Opposition

- Square of opposition is a tool used to know the relationship between propositions

The traditional square of opposition is a diagrammatic representation of the relationship between the four fundamental types of categorical propositions in Aristotelian logic. Opposition in logic does not mean conflict, but refers to the relationship between two propositions with the same subject and predicate but differing in quantity or quality or in both. There are four types of propositions: A (All S is P), E (No S is P), I (Some S is P), and O (Some S is not P). Among these, A and E differ in quality, A and I differ in quantity, and A and O, E and I differ in both quantity and quality. The square of opposition arranges these four categorical propositions in a square format, showcasing their logical connections. The propositions are placed in the four corners of the square, and lines are drawn between them to represent the relationship they share.

The following diagram helps in understanding the interplay between four types of propositions.

- Square of opposition is a tool used to know the relationship between propositions

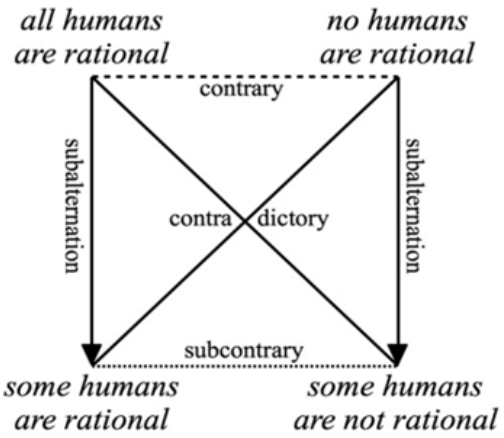

Fig 2.2.1 Square of Opposition

The four different types of oppositions are:

1. Contrary (The relation between A and E)
2. Subcontrary (I and O)
3. Subaltern (A and I; E and O)
4. Contradictory (A and O; E and I)

2.2.2.1 Contrary (A- E)

- The relation between A and E is contrary

Contrary opposition is the relation between two universal propositions which have the same subject and the same predicate, but they differ only in quality. In the traditional square of opposition, propositions A and E are contrarily opposed. The relation of Contrary Opposition is that both cannot be true at the same time, but they can both be false. In the traditional square of opposition, contrary propositions are represented by lines A and E, which do not overlap. This means that if one statement is true, the other must be false. If one is false, the truth of the other statement remains undetermined or doubtful. For example, the proposition 'All feminists are philosophers' is contrary to 'No feminists are philosophers'. In this case, if A (All feminists are philosophers) is true, then E (No feminists are philosophers) must be false. But, if A is false, we cannot be sure if E is true or false. Thus, E is doubtful.

If A is true, then E is false. But if A is false, then E is doubtful

2.2.2.2 Sub-Contrary (I- O)

Sub-contrary opposition is a relationship between two particular propositions that share the same subject and predicate but have different qualities. The relation between a Particular Affirmative (I) and a Particular Negative (O) is Sub-contrary. In the traditional square of opposition, they are represented by the letters 'I' and 'O'. In sub-contrary relation, the two particular propositions are related in such a way that both these statements cannot be false at the same time, even though they can be true. For example, the 'I' proposition 'Some birds can fly' is related to the 'O' proposition 'Some birds cannot fly' by sub-contrary opposition. If one statement is true, the other one becomes doubtful, and if one statement is false, then the other one becomes true. If the statement 'Some people are hardworking' is true, then its sub-contrary statement 'Some people are not hardworking' becomes doubtful. Conversely, if the statement 'Some individuals are not honest' is false, then its sub-contrary statement 'Some individuals are honest' becomes true.

- The relation between I and O is Sub- contrary

If 'I' is true, then 'O' is doubtful; and if 'I' is false, then 'O' is true.

2.2.2.3 Subaltern (A-I and E-O)

Subaltern opposition is a relationship between two propositions that have the same subject and the same predicate, but differ in quantity. The relation between Universal Affirmative (A) and Particular Affirmative (I) is subaltern; and the relation between Universal Negative (E) and Particular Negative (O) is also subaltern. In this relationship, the proposition with a particular quantity (I or O) is referred to as the 'subaltern', while the proposition with a universal quantity (A or E) is termed the 'superaltern'. Between subalterns, if the universal is true, its corresponding particular is also true, because if the whole is true, the part also will be true. For example; if the proposition 'All elephants have trunk' is true; its subaltern 'Some elephant has trunk' is also true. If the universal is false, its subaltern is doubtful. For example; if the statement, 'All Indians are Hindus' is false; then its subaltern 'Some Indians are Hindus' is doubtful.

- The relation between A and I, E and O are subaltern

If A is true, then I is true; If A is False; then I is doubtful.

The same is the case with E and O propositions. If the Universal Negative (E) proposition is true, then the Particular Negative (O) proposition is also true. For example, if we assert the statement 'No cats have wings' is true, then its subaltern 'Some cats do not have wings' is also true. However, if the Universal Negative (E) proposition is false, then the truth value of its subaltern Particular Negative (O) proposition becomes doubtful. For instance, if we claim 'No birds can swim' is false, then its corresponding subaltern 'Some birds cannot swim' becomes doubtful.

If E is true, then O is true; If E is false, then O is doubtful

2.2.2.4 Contradictory (A- O and E- I)

Contradictory opposition is the relation between two propositions having the same subject and the same predicate differing both in quantity and quality. The relation between Universal Affirmative (A) and Particular Negative (O) is contradictory. Universal Negative (E) and Particular Affirmative (I) are contradictory. The A proposition affirms that the entire subject category is included in the predicate category, while the O proposition denies it. The E proposition denies the existence of any members of the subject category in the predicate category, while the I proposition affirms that at least some members of the subject category are in the predicate category. Thus, among contradictories, if one is true, then the other is false, and if one is false, then the other is true.

- The relation between A and O, E and I propositions are contradictory

If A is true, then O is false; If A is false, then O is true
If E is true, then I is false; If E is false, then I is true

For instance, if the 'A' proposition, 'All squares are four-sided' is true, then its contradictory 'O' proposition, 'Some squares are not four- sided' is false, and if the 'A' proposition, 'All squares are four- sided' is false, then its contradictory 'O' proposition 'Some squares are not four- sided' is true. Likewise, if the 'E' proposition, 'No squares are four- sided' is true, then its contradictory 'I' proposition, 'Some squares are four- sided' is false, and if the 'E' proposition, 'No squares are four- sided' is false, then its contradictory 'I' proposition, 'Some squares are four- sided' is true.

Table 2.2.1 Table representing Square of Oposition

	Given	A	E	I	O
1	A True	-	False	True	False
2	A False	-	Doubtful	Doubtful	True
3	E True	False	-	False	True
4	E False	Doubtful	-	True	Doubtful
5	I True	Doubtful	False	-	Doubtful
6	I False	False	True	-	True
7	O True	False	Doubtful	Doubtful	-
8	O False	True	False	True	-

2.2.3 Immediate Inference of Eduction

- In eduction, we can derive multiple other propositions from this single proposition

Eduction is a kind of immediate inference where we infer the conclusion from a single given proposition. For example, from the 'A' proposition, 'All dogs are mammals', we can immediately infer 'All mammals are dogs'. In eduction, we can derive multiple other propositions from a single proposition, which may differ in the subject, predicate, or both. The meaning of the premise and the conclusion may remain the same in eduction. In such cases, they are known as equivalent propositions, and the difference lies only in their form or presentation. In eduction, if the given proposition is true, then all the other propositions derived from it will also be true. On the other hand, if the given proposition is false, then all the inferences drawn from it will also be false. At the same time, in opposition, the inferred proposition may or may not be true.

The different kinds of eduction are:

1. Conversion
2. Obversion
3. Contraposition
4. Inversion

2.2.3.1 Conversion

Conversion is a kind of immediate inference used for deriving a new proposition. The derived new proposition is called the converse, while the given proposition from which

- conversion interchanges the subject and predicate terms

we derive the converse is called the convertend. In conversion, interchange the subject and predicate terms of the original categorical proposition to form the new proposition. Here, the subject of the convertend becomes the predicate of the converse and the predicate of the convertend becomes the subject of the converse. For example, the 'E' proposition 'No dogs are cats' can be converted to 'No cats are dogs'.

- In conversion, the quality remains the same

When a proposition is converted, the quality (affirmative or negative) of the derived converse proposition must remain the same as the convertend. If the original proposition is affirmative, the inferred proposition should also be affirmative, and if the original is negative, the quality of the converse also should be negative. In the process of conversion, the term that is undistributed in the convertend proposition will not be distributed in the converse. If the term which is undistributed in the convertend is distributed in the converse, then that means the meaning of the proposition has been changed.

The Structure of Conversion is as follows;

Premise: S is P

Conclusion by conversion: P is S

However, not all conversions are valid, and there are specific rules and limitations based on the type of proposition involved. There are two kinds of conversion:

1. Simple Conversion

2. Conversion by Limitation or Conversion by Accidents

Simple Conversion

- Simple conversion is valid for the E and I proposition

Simple conversion is valid for E (Universal Negative) and I (Particular Affirmative) propositions. Here, conversion is carried out by transposing the subject and the predicate of a proposition without altering its form.That means, if the convertend is affirmative, the converse must also be affirmative, and if the convertend is negative, the converse must also be negative. For instance, the converse of the I proposition, 'Some students are hardworking' is logically equivalent to the proposition 'Some hardworking people are students'. Similarly, the converse of the E proposition, 'No elephants are Carnivorous' and 'No Carnivorous are elephants' are logically equivalent to it.

The converse of the E proposition is SEP into PES and the con-

verse of the I proposition is SIP into PIS.

Conversion by Limitation

Conversion by limitation is a type of conversion where the subject and the predicate are interchanged and the quantity of the convertend is altered from universal to particular. In A type proposition, it is impossible to carry out a simple conversion, because the Universal proposition 'All humans are mortal' is not logically equivalent to the proposition 'All mortal beings are human'. Here, in 'A' proposition, carried out conversion by limitation by changing the quantity from universal to particular. There is nothing wrong with inferring 'Some P is S' from 'All S is P'. For instance, from the proposition 'All humans are mortal' we convert it to 'Some mortal beings are humans'. This process ensures that the undistributed terms in the convertend remain undistributed in the converse, maintaining the statement's original meaning.

- Conversion by limitation is valid for 'A' proposition

Thus, the converse of A proposition, SAP is PIS.

In certain cases, a singular proposition can take on a universal affirmative form, when the subject is representative of an entire class. In such cases of singular propositions, where both the subject and predicate are singular terms, simple conversion can be carried out. For example, 'Mahatma Gandhi is the father of the nation' (SAP) can be converted to 'The father of the nation is Mahatma Gandhi' (PAS) without any changes in meaning.

The conversion of 'O' propositions is not valid. As the 'O' proposition is negative, the converse also should be negative. For example, the proposition 'Some birds are not herbivorous' is true, but its converse 'Some herbivorous are not birds' is false. These statements are not logically equivalent. If we convert SOP into POS, the subject that is undistributed in the convertend becomes distributed in the converse as the predicate of a negative proposition. Therefore, O propositions do not have a valid converse.

- 'O' proposition has no converse

When applying conversion, keep these points in mind.

- The subject of the premise becomes the predicate of the conclusion and the predicate of the premise becomes the subject of the conclusion.
- The quality of the converse must remain the same as the quality of the converted.
- Quantity of the premise and the conclusion should be the same as far as possible.
- No term can be distributed in the converse proposition unless it was distributed in the converted.

SAP	-	PIS
SEP	-	PES
SIP	-	PIS
SOP	-	No Converse

2.2.3.2 Obversion

- Obversion alters the quality while preserving the quantity and meaning as the same

Obversion is a way of immediate inference of eduction, where we derive a new proposition by altering the quality while preserving the quantity and the meaning as the same. The derived proposition is called the obverse and the given proposition from which the new one is derived is called obvertend. The obverse has the same subject as the obvertend and has a contradictory predicate. Through obversion, negative obvertend is transformed to positive, and vice versa.

- The obversion of SAP is SEP, and SEP is SAP

In order to obvert an 'A' proposition like, 'All crows are black' (All S is P), change it into the E proposition 'No crows are non-black' (No S is P). Here, the quality is changed from affirmative to negative, and replaced the predicate black with its contradictory 'non-black'. Thus, the obversion of SAP is SEP. To obvert an E proposition (No S is P), first change it into an A proposition (All S is P) by changing the quality from negative to affirmative, and replacing the predicate term with its contradictory. For instance, the E proposition 'No cats are horses' can be obverted into 'All cats are non-horses'. Thus, the obversion of SEP is SAP.

In order to obvert an I proposition (Some S is P), first change it into an O proposition (Some S is not P) by changing the quality from affirmative to negative and using the contradictory of the original predicate term. For instance, the obversion of the I proposition, 'Some flowers are fragrant' is 'Some flowers

- The obversion of SIP is SOP, and SOP is SIP

are non-fragrant'. Thus, the obversion of SIP is SOP. To obvert an O proposition (Some S is not P), convert it into an I proposition (Some S is P) by changing the quality from negative to affirmative and replacing the predicate term with its contradictory. For instance, the obversion of the 'Some men are not honest' is 'Some men are non- honest'. Thus, the obversion of SOP is SIP.

When applying obversion, keep these points in mind.

- The subject of the premises is the subject of the conclusion.
- The predicate of the conclusion is contradictory of the predicate of the premise.
- The quantity of the premises and conclusion must remain the same.
- Quality of the premise and the conclusion are different. If the premise is affirmative then the conclusion is negative and if the premise is negative, the conclusion is affirmative.
- The rule of the distribution of the term is to be observed

Obvertend	Obverse
SAP	SEP
SEP	SAP
SIP	SOP
SOP	SIP

Material Obversion

- Material obversion checks the content and meaning of the proposition

In formal obversion, we change the quality (affirmative to negative or vice versa) and the predicate of a given proposition to create a new proposition. The subject of the new proposition remains the same as the original. However, according to the Scottish philosopher Alexander Bain, formal obversions are distinct from material obversions. In material obversion, we understand and examine the content and meaning of the proposition, rather than following strict logical rules. Here, we change the subject of the proposition to its contrary counterpart while keeping the same quality and arriving at new inferences based on our knowledge and experience. For instance, the material obversion of the proposition 'Success brings happiness' is 'Failure brings sadness'. In this proposition, the subject 'Success' is contrary to the subject 'Failure', and the quality remains affirmative. The

predicate 'happiness' becomes 'sadness', which is its contrary counterpart.

2.2.3.3 Contraposition

Contraposition is another kind of immediate inference of eduction used to derive a new proposition from the given proposition. Here the subject of the derived proposition is the contradictory of the original predicate, and the predicate of the derived proposition is the contradictory of the subject of the given proposition. For example, the contraposition of 'A' proposition, 'All dogs are mammals' is 'All non-mammals are non- dogs'.

- Subject: Contradictory of the original predicate, Predicate: Contradictory subject of the given proposition

In order to get the contrapositive, first we have to obvert the given proposition and then convert it. The resultant one is the converted obverse of a given proposition. This converted obverse is the partial contrapositive. If we obverted this again, we get full contrapositive.

Table 2.2.2 Contrapositive of A, E and O

Given Proposition	Obverse	Converse (Partial Contrapositive)	Obverse (Full Contrapositive)
SAP	SEP	PES	PAS
SEP	SAP	PIS	POS
SIP	SOP	No Converse	------
SOP	SIP	PIS	POS

2.2.3.4 Inversion

Inversion is an immediate inference of eduction, in which a new proposition is derived from the given proposition. The derived proposition has the subject as the contradictory of the given subject and predicate as the contradictory of the given predicate. Only universal propositions A and E can be inverted. It is impossible to carry out inversion in a particular proposition, as it is related to specific or concrete instances, and the truth values are not easily transformed without changing the content of the statement. To obtain the full inverse of an 'A'

- Inversion is applicable only in universal propositions like A and E

proposition, we follow a four-step process. Firstly, we obvert the 'A' proposition, then convert it. After that, we obvert the converted proposition, and finally, we convert it again. The result of this sequence is the full inverse of the original 'A' proposition. If we obvert this again; we get partial inverse. On the other hand, for an 'E' proposition, we begin with conversion, which gives us the partial inverse first, and then the full inverse.

For A proposition - Obvert- Convert- Obvert- Convert

For E proposition - Convert- Obvert- Convert- Obvert

Thus,

SAP - SEP- PES- PAS- SIP

SEP - PES- PAS- SIP- SOP

The inversion of an 'A' proposition, 'All dogs are mammals' is 'Some non- dogs are non- mammals'.

Summarized Overview

In Logic, deductive inference is classified into immediate inference and mediate inference. Immediate inference draws conclusions directly from a single given premise, while mediate inference involves drawing conclusions from more than one premise. Both types of deductive reasoning follow the rule of distribution of terms, stating that a term distributed in the conclusion must also be distributed in the premises. Immediate inference can be classified into the immediate inference of opposition and immediate inference of eduction. Immediate inference of opposition explores the relationships between different types of propositions, such as A (All S is P), E (No S is P), I (Some S is P), and O (Some S is not P), using the traditional square of opposition. While, the immediate inference of eduction includes conversion, obversion, contraposition, and inversion. Conversion involves interchanging a proposition's subject and predicate terms, while obversion alters the quality of a proposition while preserving its quantity and meaning. Contraposition derives a new proposition by obtaining the converted obverse of a given proposition, and inversion is applicable only to universal propositions (A and E), involving obversion and conversion. Apart from this, there is also mediate inference, which helps to draw conclusions from more than one premise that can be discussed in the next unit.

Self-Assessment

1. What is inference and why is it important in reasoning?
2. How can inferences be classified?
3. What is the immediate inference?
4. Explain the relation of the contrary by using an example.
5. How are the propositions 'A', 'E', 'I', and 'O' related? Explain the relation with the help of the traditional square of opposition.

Assignments

1. What is the square of opposition, and how does it illustrate the relationship between different types of propositions?
2. Discuss the process of conversion, obversion, contraposition, and inversion in Eduction. Provide an example for each.
3. How can a thorough understanding of the different types of immediate inference help in constructing sound arguments and identifying fallacies in reasoning? Provide examples.

Reference

- Copi, I. M., & Cohen, C. (2017). *Introduction to Logic*. Routledge.
- Hurley, P. J. (2016). *A Concise Introduction to Logic*. Cengage Learning.
- Creighton, J. E., & Smart, J. J. C. (1973). *An Introduction to Logic* (2nd ed.). Routledge.

Suggested Reading

- Bergmann, M., Moor, J., & Nelson, J. (2019). *The Logic Book.* McGraw-Hill Education.
- Bealer, G. (2020). "Propositional Logic", *The Stanford Encyclopedia of Philosophy* (Summer 2020 Edition), edited by E. N. Zalta. Stanford University.
- Graham, P. (2020). "Immediate Inference". *The Stanford Encyclopedia of Philosophy* (Fall 2020 Edition), edited by E.N. Zalta. Stanford University.

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UNIT 3
Mediate Inference

Learning Outcomes

After the completion of this unit, the learner will be able to

- comprehend the concept of categorical syllogism and its component parts
- understand the rules of categorical syllogism
- identify the common fallacies of syllogism
- familiarise with Venn diagrams and their application in determining the validity of a syllogism
- construct valid syllogisms using the standard form and appropriate moods and figures

Background

In our previous discussions, we concentrated on immediate inference, where a conclusion is drawn directly from a single given proposition. However, there exists another type of inference known as mediate inference, which draws conclusions through the connection of intermediate steps, creating a coherent logical chain of thought. Mediate inference was first developed by the ancient Greek philosopher Aristotle, and it has been used in many different fields of study ever since. Within the realm of mediate inference, a special emphasis is placed on syllogism, a captivating logical structure comprising two premises and one conclusion. Syllogism provides a structured approach to evaluating arguments systematically, serving as a potent tool for constructing well-founded reasoning. Nevertheless, it is important to note that not all syllogisms are valid; adherence to specific rules is essential to ensure their validity. Failure to fulfil these rules can lead to logical fallacies, undermining the strength and validity of an argument. Here, we are going to discuss, in particular, categorical syllogism, the rules, fallacies, figures, and moods.

Keywords

Syllogism, Illicit major, Illicit minor, Moods, Figures, Venn diagrams

Discussion

2.3.1 Mediate Inference

- Mediate inference has two or more propositions

Mediate inference is a kind of deductive reasoning, which has two or more propositions as premises. As the term 'mediate' denotes, mediate inference involves a minor premise or second proposition. From these premises taken together, we draw a new conclusion. It is by connecting these premises logically that we can derive a new proposition as the conclusion.

eg:- All humans are mortal — Premise 1

All mortals are vulnerable to diseases — Premise 2

Rohit is a human — Premise 3

Rohit is mortal — Premise 4

∴ Rohit is vulnerable to diseases } — Conclusion

2.3.2 Syllogism

- Syllogism consists of three propositions

Syllogism is a mediate inference having two and only two premises. It is a powerful tool for reasoning that helps us to combine the given premises logically to reach a solid conclusion. The word 'syllogism' comes from the Greek word 'syllogismos,' which means 'conclusion' or 'inference.' According to Jevons, 'A syllogism is an act of thought by which, from two given propositions, we proceed to a third proposition, the truth of which necessarily follows from the truth of the given propositions.'

An example of a syllogism is as follows;

All humans are mortal _____ Premise 1

All teachers are human _____ Premise 2

∴ All teachers are mortal _____ Conclusion

- Syllogism assists in logical reasoning

The essence of the syllogism is about using logical reasoning to draw conclusions from related information. It helps us establish new facts based on what we already know. Syllogism assists us in reasoning effectively and reaching well-founded conclusions. By mastering this logical skill, we can improve our critical analysis and engage in more convincing arguments and discussions. Syllogisms are classified as categorical or non-categorical (compound). There are two main types of syllogism: conditional and unconditional. A conditional syllogism can be further divided into two categories: mixed and pure.

2.3.2.1 Structure of a Syllogism

- Syllogism has two given premises and one derived conclusion

The structure of a syllogism is based on the arrangement of terms and the relationship between them. The three terms in a syllogism are the major term, the minor term, and the middle term. Each term occurs twice in a syllogism. The major term is the predicate term of the conclusion and is represented by the letter 'P'. The major premise is where the major term is present. The minor term is the subject term of the conclusion and is represented by the letter 'S'. The minor premise is where the minor term is present. The term which appears only in the premises and not in the conclusion is called the 'Middle term' and is represented by the letter 'M'. It is the middle term, which mediates the connection between the other two terms. The reason the middle term is so-called is because it acts as a bridge, connecting the other two terms.

The proper order of a syllogism is:

major premise

minor premise

conclusion.

For example, in the syllogism

All humans are mortal	Premise 1 (Major Premise)
Rohit is a human	Premise 2 (Minor Premise)
∴Rohit is mortal	} Conclusion

- Subject of the conclusion is the minor term (S)
- Predicate of the conclusion is the major term (P)

In this example, we have a syllogism with three propositions. The subject term of the conclusion is 'Rohit', which is also found in the minor premise, represented by the letter 'S'. The predicate term of the conclusion is 'Mortal', which is also present in the major premise, represented by the letter 'P'. The middle term in this syllogism is 'human', which appears only in the premises and is represented by the letter 'M'.

- Categorical syllogism has three categorical propositions

A Categorical syllogism is an unconditional syllogism. In a categorical syllogism, all propositions (two premises and a conclusion) are categorical propositions. Categorical propositions are concerned with categories or classes of things. Each proposition contains three different terms, and each term occurs twice in the syllogism. The structure of a categorical syllogism can be represented in standard form, in which the major premise comes first, then the minor premise comes and the conclusion comes in the end.

The standard form of a categorical syllogism is a type of argument that follows four specific rules. They are;

1. All three propositions should be in the standard form of categorical propositions, with proper quantifiers, subject terms, copulas, and predicate terms.
2. Each term should appear twice in identical forms.
3. Each term must be used consistently with the same meaning throughout the argument, avoiding any ambiguity.
4. To be in standard form as a categorical syllogism, the major premise should be listed first, followed by the minor premise, and the conclusion

2.3.3 Rules and Fallacies of Categorical Syllogism

- If a syllogism is valid, it must follow certain rules

Aristotle, the father of logic, was the first to suggest that valid syllogisms must adhere to specific rules. Logicians today agree on five or six such rules. If a syllogism follows all these rules, it becomes valid. However, if it breaks any of these rules, it commits a fallacy and thus the syllogism becomes invalid. The following are the rules of a valid categorical syllogism.

Rule 1- *A valid standard-form of categorical syllogism must contain exactly three terms, each of which is used in the same sense throughout the argument.*

- Valid categorical syllogism has only three terms and is used in the same sense throughout

As stated above, in a categorical syllogism, there are three main terms: the subject (minor term), the predicate (major term), and the middle term or the common term. To make a valid conclusion, major and minor terms need to relate to the middle term. This relationship between terms in the premises should remain consistent to derive a strong argument. To ensure the validity of syllogism, it is necessary to stick to these three terms- no more and no less. If one is using more than three terms or uses the terms in different senses then the syllogism becomes invalid resulting in a fallacy of four terms or quartentio- terminorum.

For example;

- The fallacy of four terms is called quartentio-terminorum

Saritha is the cousin of Radha

Lalitha is the cousin of Saritha

∴Lalitha is the cousin of Radha

Here involves 4 terms, such as; Saritha, Cousin of Radha, Lalitha, and Cousin of Saritha.

This fallacy also occurs when words or phrases are used with different meanings. If a term has two different meanings, it acts as equivalent to two terms. This eventually leads to a false conclusion and, thus, it commits the fallacy of equivocation. The three forms of the fallacy of equivocation are:

- Fallacy of ambiguous major
- Fallacy of ambiguous minor
- Fallacy of ambiguous middle

The fallacy of ambiguous major occurs when the major term is used in one sense in the major premise and in a different sense in the conclusion.

eg:- All banks are financial institution

The river is not a financial institution

∴Therefore, the river is not a bank

In this syllogism, the major term 'bank' is used with two different meanings: as a 'financial institution' in the major premise and as 'the side of the river' in the conclusion. This

inconsistency in the use of the major term leads to the fallacy of an ambiguous major. The fallacy of an ambiguous minor occurs when the minor term is used in one sense in the minor premise and another sense in the drawn conclusion. For example,

eg:- No man is made of paper

All pages are men

Therefore, No pages are made of paper

The ambiguity stems from a shift in the meaning of the term 'pages' between the minor premise and the conclusion. In the minor premise, the term 'pages' refers to young individuals employed in a hotel, whereas in the conclusion, 'pages' is interpreted as the sheets in a book. The use of different senses of the word in the premise and conclusion has resulted in confusion within the logical structure of the argument.

The fallacy of the middle term occurs when the middle term is used in one sense in the major premise and in another sense in the minor premise. For example,

Sound travels 1120 feet per second

My knowledge of philosophy is sound

Therefore, my knowledge of philosophy travels 1120 per second

- Fallacy of ambiguous major, minor and middle occurs when the terms are used in a different sense in a syllogism

In this syllogism the ambiguity arises from the term 'sound,' (the middle term)which is used in different senses in both premises. In the major premise, 'sound' refers to the physical phenomenon of vibrations traveling through a medium, like air, at a speed of 1120 feet per second. In the second premise, 'sound' is used metaphorically to indicate that one's knowledge of philosophy is reliable, well-founded, or free from error. To avoid these ambiguities, it is important to use terms consistently in both premises and ensure that the conclusion logically follows from the established premises.

Rule 2 – *Every syllogism must contain three and only three propositions*

- Every syllogism must contain only three propositions

This rule is a part of the definition of a syllogism. A syllogism is a way of reasoning where we start with two propositions (premises) and then derive into a conclusion based on those propositions. We reach the final conclusion by using these two propositions. Thus, there should be only three propositions.

Rule 3- *Distribute the middle term in at least one premise.*

- TIn a valid syllogism, the middle term must be distributed at least once

The middle term in a syllogism serves as a common standard of reference for comparing the major and minor terms. The major term is compared with the middle term in the major premise, and the minor term is compared with the middle term in the minor premise. This comparison between the minor and major terms is possible because of the mediation of the middle term. In a valid syllogism, the middle term should be distributed in at least one premise to create a clear and logical connection between the subject and the predicate of the conclusion. In other words, it is essential to talk about the whole class of middle term in at least one of the premises. If the middle term is not fully distributed in any premise, then the major and minor terms may end up being compared to different parts of the middle term. This can lead to an invalid conclusion because the relationship between the major and minor terms is not properly established.

For instance, consider this syllogism:

All dogs are animals

All cats are animals

∴All cats are dogs

Here, the middle term 'animals' is not fully mentioned in either premise and thus is not fully distributed. ('A' proposition does not distribute predicate) There are animals other than dogs and cats. To avoid this fallacy, we need to ensure that the middle term is used in its entirety in at least one premise.

Rule- 4 *Any term distributed in the conclusion must be distributed on the premises/ The term that is undistributed in the premises, cannot be distributed in the conclusion.*

When a term is 'undistributed' in the premises, it refers to only a part of the members of the class being taken into account. On the other hand, when the term is considered 'distributed' that indicates all the members of the class. Therefore, if a term that is undistributed in the premises becomes distributed in the conclusion, the conclusion becomes invalid because a valid argument should not assert more in the conclusion than what is already stated in the premises. If the conclusion introduces anything beyond what is expressed in the premises, it commits fallacies, such as

- The term which is undistributed in the premises, cannot be distributed in the conclusion

- Fallacy of illicit major
- Fallacy of illicit minor

The fallacy of illicit major occurs when the major term in the conclusion is distributed, which is undistributed in the major premise.

eg:- All dogs are mammals

No crows are dogs

∴No crows are mammals

- Fallacy of illicit major means, the undistributed major term in the major premise is distributed in the conclusion

In this syllogism, the major term 'mammals' is undistributed as it refers only to a part of the class. The fallacy of illicit major occurs when the same major term is distributed in the conclusion, making a broader claim than what the premises support. In this case, the major term 'mammals' is indeed distributed in the conclusion as it refers to the entire class, leading to the fallacy of an illicit major.

The fallacy of illicit minor occurs when the minor term in the minor premise is undistributed; which is distributed in the conclusion.

For instance, the syllogism

All dogs are mammals

All dogs are warm-blooded animals

∴All warm-blooded animals are mammals

- Fallacy of illicit minor: Minor term undistributed in premise, and is distributed in conclusion

In this syllogism; the minor term 'warm-blooded animals' is distributed in the conclusion but not distributed in the premises. The minor premise here is only concerned about dogs, not

all warm-blooded animals. While, the conclusion goes beyond what the minor premises actually support, thus making it a fallacy of illicit minor.

Rule 5 – *From two negative premises, no conclusion is possible*

- From two negative premises, no conclusion can be drawn

In a syllogism, if both premises are negative, we cannot draw a valid conclusion. Negative premises exclude certain things from a group and create a sense of exclusion among classes. When two premises are negative, it means that the minor term (S) is excluded, either fully or partially, from all or part of the middle term (M), and the major term (P) is excluded either fully or partially, from all or part of the middle term (M). The negative premises cannot provide information about whether S and P are related by inclusion or exclusion, partially or completely. Therefore, with both premises being negative, we cannot arrive at a reliable conclusion in the syllogism. The lack of a common link (middle term) between S and P makes it impossible to establish any relationship between them, resulting in an invalid conclusion. This error is known as the fallacy of two negative premises in a syllogism.

For example:

No hens are mammals (E proposition)

No ducks are hens (E proposition)

No Conclusion

We cannot conclude anything about the relationship between ducks and mammals.

When both premises are negative, it becomes challenging to establish a valid argument because there is no clear link between the minor and major terms. Hence, we cannot draw a reliable conclusion from such premises. This error is known as the fallacy of two negative premises or the fallacy of exclusive premises in a syllogism.

Rule 6 - *If either premise is negative, the conclusion must be negative*

- Affirmative conclusion is derived only from two affirmative premises

A valid affirmative conclusion can only be drawn from two affirmative premises. To draw a valid conclusion, all three classes (S, P, and M) must be explicitly stated in the premises. This type of inclusive relationship between classes can only be expressed using affirmative premises. So, for a valid affirmative conclusion, we need two affirmative premises. To ensure validity, if one premise is negative, the other premise must be affirmative, and the derived conclusion must be negative. Otherwise, it commits the fallacy of drawing an affirmative conclusion from a negative premise.

- If one premise is negative, the conclusion also should be negative

When a syllogism includes a negative premise, it signifies that the middle term 'M' does not share a common characteristic or property with one of the other terms (S or P). Conversely, an affirmative premise indicates that 'M' does share a common characteristic or property with one of the other terms. When one premise is negative, in the process of mediating between S and P, 'M' can only demonstrate the absence of inclusion (exclusion) between S and P in the conclusion. Therefore, the conclusion must also be negative. This rule prevents the error of inferring an affirmative conclusion from a negative premise.

For example:

No businessmen are politicians

Some actors are businessmen

∴Some actors are politicians

In this example, the negative premise states the exclusion of businessmen and politicians, but it does not provide enough knowledge to draw a valid inference about the inclusion of actors and politicians. Thus, this syllogism commits the fallacy of drawing an affirmative conclusion from a negative premise.

Rule 7- *Two particular premises yield no valid conclusion*

The two particular propositions are I and O; the following are the four possible combinations of these particular premises.

I I O O

I O O I

- No valid conclusion can be drawn from the two particular premises

Among the syllogistic combinations presented, the first combination is 'I and I', where both premises are in the form of the particular proposition 'Some S is P' (I proposition). This 'I' proposition refers to some, but not all, of the members of the class 'S' and 'P'. Since neither the subject 'S' nor the predicate 'P' is distributed in the 'I' proposition, it violates the rule that the middle term must be distributed at least once for a valid syllogism. Therefore, this combination is invalid.

The second combination, 'O and O', is also invalid because both premises are in the form of negative propositions ('O' propositions). According to the rules of syllogism, we cannot draw a valid conclusion from two negative propositions. This combination violates the rule that two negative premises cannot lead to a valid argument. Thus, this combination is also eliminated.

Amongst the remaining combinations, 'I and O' and 'O and I', each contains one affirmative premise and one negative premise. Thus, the conclusion in both cases should be negative. That means the conclusion should be an 'O' proposition (Particular negative). In a negative conclusion (O Proposition), the predicate term (P) is distributed, and for that to happen, it must also be distributed in the major premise. But in these combinations, the only term distributed is the middle term (M). As a result, the fallacy of illicit major occurs, which happens when the major term in the conclusion is distributed but remains undistributed in the major premise. Thus, from the two particular premises, it is impossible to derive a valid conclusion.

Rule 8 - *If any one premise is particular, the conclusion must be particular*

There are eight possible combinations of one particular premise and one universal premise. They are;

A	I	A	O	E	I	E	O
I	A	O	A	I	E	O	E

Out of the eight combinations, the combinations of 'I and E', 'E and O', and 'O and E' are invalid because of the following reasons. The combination of 'I and E' has an 'I' proposition as the major premise, where neither the subject nor the predicate is distributed. However, the conclusion is an 'O'

- If one premise is particular, the conclusion must be particular

proposition where the major term (predicate) is distributed. This commits the fallacy of illicit major. Similarly, the combinations of 'E and O', and 'O and E' both have two negative premises ('E' and 'O' propositions). According to the rules of syllogism, we cannot draw a valid conclusion from two negative premises. Therefore, these combinations are also invalid.

Thus, of these eight combinations, the remaining valid combinations are;

A	I	A	O	E
I	A	O	A	I

- In an 'A' proposition, the subject term is distributed
- The valid conclusion drawn from the 'A' & 'I' proposition is 'SIP'

When we consider the combinations of 'A and I' and 'I and A,' only one term is distributed. In 'A' proposition, the subject term is distributed, while in 'I' proposition, neither the subject nor the predicate is distributed. To avoid the fallacy of undistributed middle, the middle term (M) must be distributed in at least one of the premises. Thus, here the distribution of 'A' proposition must be assigned to the middle term (M). In these combinations, the subject term (S) and the predicate term (P) are not distributed in the premises. Therefore, they cannot be distributed in the conclusion as well. So, the only valid conclusion that can be drawn is 'SIP' (Some S is P).

- The only valid conclusion drawn from the 'A' & 'O' premise is 'SOP'

When we consider the combinations of 'A and O' and 'O and A,' they both distribute two terms, and one should go to the middle term (M) and the other to the predicate term (P) because the conclusion is negative due to one premise being negative. In these combinations, the subject term (S) is undistributed in the minor premise, so it cannot be distributed in the conclusion to avoid the fallacy of illicit minor. Therefore, the only valid conclusion that can be drawn is 'SOP' (Some S is not P).

- The only valid conclusion drawn from the 'E' & 'I' propositions is 'SOP'

In the 'E and I' syllogism, two terms are distributed. One of the distributions must be the middle term to avoid the fallacy of undistributed middle. The other distribution must be the major term because the conclusion is negative due to the syllogism having one negative proposition (E). The possible negative conclusions are 'E' or 'O' propositions. If the conclusion is an 'E' proposition, both the subject and predicate terms are distributed, but the minor term in the minor premise (I proposition) is not distributed, leading to the fallacy of illicit minor. However, if the conclusion is an 'O' proposition, only the major term is distributed. The major term is already distributed

in the major 'E' premise. Therefore, the only valid conclusion that can be drawn is 'SOP' (Some S is not P).

Rule 9 - *From a particular major premise and a negative minor premise, we cannot get a conclusion*

The possible combination of a particular major and a negative minor premises are;

I O
E O

Among these combinations, the 'O and O' combination is eliminated because it has two negative premises, and it is not possible to draw a valid conclusion from two negative premises. In the combination of 'I and E' propositions, since one premise is negative, the conclusion must also be negative. In the negative conclusion, the predicate term (P) will be distributed. To have a valid conclusion, the distributed predicate term (P) must also be distributed in the major premise. However, the major premise is an 'I' proposition, and in this case, no term is distributed. Therefore, the syllogism commits the fallacy of illicit major. As a result, no valid conclusion can be drawn from a particular major premise and a negative minor premise.

- It is impossible to draw conclusions from particular major and negative minor premise

2.3.4 Venn Diagram Technique for Testing Syllogisms

Venn diagrams are a straightforward and intuitive method to assess the validity of categorical syllogisms. For this, we draw three circles that overlap each other, creating seven distinct areas within the diagram. First, label each circle with one of the three terms in the syllogism: the subject (S), the predicate (P), and the middle term (M). The specific order of labelling is that which denotes the subject of the conclusion in the lower-left circle, the predicate in the lower-right circle, and the middle term in the top circle. This labelling system aligns with the standard structure of a syllogism, making it easier to understand.

- Venn diagram is the straightforward method to assess the validity of syllogism

When using this technique, it is important to visually analyse the relationships between the different groups or classes represented by the terms. This helps to check the

- Venn diagram is a simple and powerful tool to evaluate categorical syllogism

validity of the argument and identify any logical fallacies. In short, Venn diagrams provide a simple and powerful tool for understanding and evaluating categorical syllogisms. The test involves transferring the information from the premises to the diagram and checking if it logically leads to the truth of the conclusion. If it does, the argument is valid; otherwise, it is considered to be invalid.

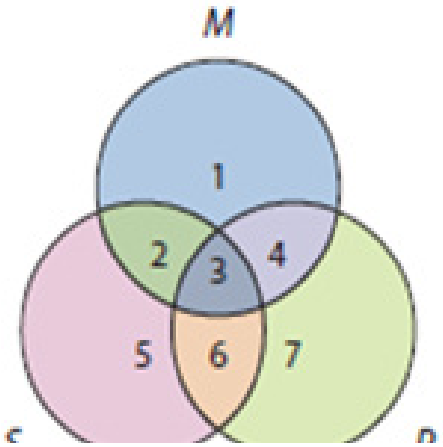

Figure 2.3.1 Venn diagram for testing Syllogism

- In the diagram, each area corresponds to the specific class

In this diagram, each area corresponds to specific class combinations. For instance, the area '1' represents things that belong to class M, but not to classes S or P. Similarly, area '2' represents things that belong to both class S and class M, but not class P. The number '3' denotes the member who belongs to all three classes M, S, and P. The number '4' denotes the members who belong to class M and class P, but not class S. The number '5' denotes the members who belong to class S, but not to the classes of M or P. The number '6' indicates the groups which come under both class S and class P, but not class M. The number '7' denotes the things which come under the class P, and not the class of S and M.

The techniques used in Venn Diagrams are:

1. Mark the premises by shading or denoting an X in the diagram; no marks are needed for the conclusion.
2. If the argument has a universal premise, start by entering that premise in the diagram. If there are two universal premises, either can be entered first.
3. Focus on the circles corresponding to the two terms mentioned in each premise, giving minimal attention to the third circle.

4. When checking the completed diagram to see if it supports a particular conclusion, the particular statements make two assertions. For example, 'Some S is P' means 'At least one S exists and that S is P' and 'Some S is not P' means 'At least one S exists and that S is not a P'.
5. When shading an area on the diagram, make sure to shade all of the areas completely.
6. Do not place an X outside of the diagram or at the intersection of two lines. Keep it within the marked areas.

2.3.5 Figures and Moods of Categorical Syllogism

2.3.5.1 The figure of a syllogism

- Figure of a syllogism is determined by the position of the middle term

The form of a syllogism has been determined by analysing two factors. They are moods and figures. The figure of a syllogism is determined by the position of the middle term in the two premises of a categorical syllogism. In other words, it depends on where the middle term is located in the syllogism.

There are four possible combinations for the position of the middle term in a syllogism. They are:

MP	PM	MP	PM
SM	SM	MS	MS
∴SP	∴SP	∴ SP	∴ SP

Special Canons or Rules of the First Figure

MP
SM
∴SP

1. Minor premise must be affirmative
2. Major premise must be universal

If the minor premise is negative, then the conclusion must also be negative, and the negative propositions distribute the major term 'P'. To ensure validity to avoid the fallacy of illicit major, the major term 'P' must be distributed in both the conclusion and the major premise. Since only negative propositions distribute their predicates, the major premise needs

- Minor premise must be affirmative in the first figure

to be negative. By supposition, the minor premise is already negative. Since we have two negative premises, it is impossible to draw any conclusion. Therefore, the minor premise must be affirmative.

- Major premise must be universal in the first figure

The second rule states that the major premise must be universal. As per the first rule, the minor premise should be affirmative. Since affirmative propositions do not distribute their predicates, the middle term 'M' is not distributed in the minor premise. However, it is essential to distribute the middle term at least once to avoid the fallacy of undistributed middle. To rectify this fallacy, the major premise, where 'M' appears as the subject, must be universal. On the other hand, particular propositions do not distribute their subjects. This ensures the proper distribution of the middle term and makes the syllogism valid.

Special Canons or Rules for the Second Figure

PM

SM

———

∴SP

1. One premise must be negative
2. Major premise must be universal

- One premise must be negative in the second figure

If both premises are affirmative, then the middle term 'M' will not be distributed in either of the premises because affirmative propositions do not distribute their predicates. In this figure, since 'M' is the predicate in both premises, one of the premises must be negative to avoid the fallacy of undistributed middle. This ensures that the middle term is distributed at least once, making the syllogism valid.

- Major premise must be universal in the second figure

In the second figure of the syllogism, as per the first rule, one premise must be negative. Consequently, the conclusion must also be negative. Negative propositions distribute the predicate term 'P' in the conclusion. Since the major term 'P' is distributed in the conclusion, it must also be distributed in the major premise to escape from the fallacy of illicit major. In this second figure, the major term 'P' appears as the subject in the major premise. Only a universal proposition distributes the subject, thus it is necessary for the major premise to be universal.

Special Canons or Rules for the Third Figure

MP
MS
—
∴SP

1. Minor premise must be affirmative
2. Conclusion must be particular

- In the third figure, the minor premise must be affirmative

If the minor premise is negative, the conclusion will also be negative. Negative propositions distribute the major term 'P'. As the major term is distributed in the conclusion, it must also be distributed in the major premise to avoid the fallacy of illicit major. In this figure, 'P' is the predicate of the major premise, and only negative propositions distribute their predicates. Therefore, the major premise must be negative. However, since we have already considered that the minor premise is negative, having two negative premises leads to an invalid conclusion. It is impossible to draw a valid conclusion from two negative premises. Thus, the minor premise needs to be affirmative.

- The conclusion in the third figure must be particular

According to the first rule, the minor premise must be affirmative. In this figure, the minor term 'S' in the minor premise appears in the position of the predicate and is undistributed as it is affirmative. Therefore, it cannot be distributed in the conclusion, as doing so would lead to the fallacy of illicit minor. Only particular propositions do not distribute their subjects. So, it is necessary that the conclusion must be particular.

Special Canons or Rules for the Fourth Figure

PM
MS
—
∴SP

1. If one premise is negative, the major premise must be universal
2. If the major premise is affirmative, the minor premise must be universal
3. If the minor premise is affirmative, the conclusion must be particular

If one premise is negative, then the conclusion in a syllogism will also be negative. In negative propositions, the major term 'P' is distributed. Thus, it must be distributed in the major

- If one premise is negative in the fourth figure, the major must be universal

premise also to avoid the fallacy of illicit major. In this figure, the major term 'P' appears as the subject in the major premise. Only propositions that are universal in nature distribute their subjects. Therefore, the major premise must be a universal proposition.

If the major premise is affirmative, the middle term (M) remains undistributed because affirmative statements do not distribute their predicates. Hence, to escape from the fallacy of undistributed middle, the minor premise must be universal. In this figure, the middle term is the subject of the minor premise, and only universal propositions distribute the subject. Hence, it is necessary that, if the major premise is affirmative, the minor premises must be universal.

- The minor premise must be universal if the major is affirmative in the fourth figure

If the minor premise is affirmative, the minor term, which is the predicate of the minor premise, remains undistributed. Thus, it must not be distributed in the conclusion. Otherwise, it commits the fallacy of illicit minor. Only the particular proposition does not distribute the minor term. Hence, the conclusion must be a particular proposition.

2.3.5.2 Moods of a syllogism

- The mood of a syllogism is determined by the quantity and quality of propositions

Every syllogism possesses a mood, which is determined by the types of categorical propositions a syllogism contains. The mood of a syllogism is based on both the quantity and the quality of the involved propositions. It is represented by three letters - the first letter of the mood denotes the major premise of the syllogism, the second letter denotes the minor premise, and the third letter denotes the type of the conclusion. For instance, consider if the major premise is an 'A' proposition, the minor premise is an 'I' proposition, and the conclusion derived is an 'I' proposition, then the mood of the syllogism is 'AII'. Not all combinations of the categorical propositions A, E, I, and O will result in a valid syllogism. Certain conditions must be met for a combination of three propositions to form a valid mood in any figure. The following are the different combinations that we get if we combine together different propositions.

A A A A	E E E E	I I I I	O O O O
A E I O	A E I O	A E I O	A E I O

All these combinations do not satisfy all the general rules of syllogism. Thus, among these 16 combinations, E & E, E & O, O & E, O & O are rejected. Because these combi-

- Certain conditions are satisfied by these valid combinations in order to become valid

nations contain two negative propositions. From two negative propositions, no conclusion can be drawn. I & I, I & O and O & I are also rejected because these combinations include two particular premises and it is impossible to draw a conclusion from two particular premises. The combination of I & E propositions is also rejected as it commits the fallacy of illicit major.

The remaining eight valid combinations are;

A	A	A	A	E	E	I	O
A	E	I	O	A	I	A	A

Each of these 8 pairs of categorical propositions must adhere to all the general rules of syllogism. After that, we need to apply the specific rules for each of the 4 figures to determine the validity of the syllogism.

The valid Mood of the First Figure

According to the rule of the first figure,

1. Minor premise must be affirmative
2. Major premise must be universal

- BARBARA, DARII, CELARENT, FERIO

By applying these rules to the eight combinations, 'A & E' and 'A & O' are rejected because the minor premise here is a negative proposition, violating the first rule of the first figure. Among the remaining 6 combinations, 'I & A' and 'O & A' are also rejected as the major premise here are particular propositions, violating the second rule of the first figure. Thus, we are left with the remaining 4 valid moods. They are;

A	A	E	E
A	I	A	I
A	I	E	O

The moods are AAA, AII, EAE, EIO- BARBARA, DARII, CELARENT, FERIO

The Valid Moods of the Second Figure

According to the rule of the second figure:

1. One premise must be negative
2. Major premise must be universal

By applying these rules to the eight combinations, 'A & A', 'A & I', and 'I & A' are rejected because they involve both universal propositions, violating the first rule of the second figure. The combination of 'O & A' is also rejected as it involves a particular major premise, violating the second rule of the second figure. Thus, we get the remaining 4 valid moods. They are;

- CAMESTRES, BAROCO, CESARE, FESTINO

A	A	E	E
E	O	A	I
E	O	E	O

The valid moods are, AEE, AOO, EAE, EIO- CAMESTRES, BAROCO, CESARE, FESTINO

The Valid Moods of the Third Figure

According to the rule of the third figure:

1. Minor premise must be affirmative
2. Conclusion must be particular

By applying these rules to the eight combinations, 'A & E' and 'A & O' are rejected because both of these combinations involve negative minor premises, violating the first rule of the third figure. 'A & A' and 'E & A' are also rejected because the conclusion is not particular, violating the second rule of the third figure. The remaining valid moods of the third figure are:

- DATISI, FERISON, DISAMIS, BOKARDO

A	E	I	O
I	I	A	A
I	O	I	O

The valid moods are AII, EIO, IAI, OAO- DATISI, FERISON, DISAMIS, BOKARDO

The Valid Moods of the Fourth Figure

According to the rule of the fourth figure:

1. If one premise is negative, the major premise must be universal
2. If the major premise is affirmative, the minor premise

must be universal

3. If the minor premise is affirmative, the conclusion must be particular

By applying these rules to the eight combinations, we reject the 'O & A' combination because it contains one negative premise while the major premise is negative, violating the first rule of the fourth figure. Among the remaining combinations, 'A & I' and 'A & O' are rejected because they have an affirmative major premise but a particular minor premise, which is against the second rule of the fourth figure. From the remaining, 'A & A' and 'E & A' are rejected because they have affirmative minor premises but a universal conclusion, violating the third rule of the fourth figure. Thus, the remaining valid moods of the fourth figure are:

- CAMENES, FRESISON, DISMARIS

A E I

E I A

E O I

The valid moods are AEE, EIO, IAI- CAMENES, FRESISON, DISMARIS

Summarized Overview

Mediate inference, as a form of logical reasoning, plays a crucial role in drawing conclusions based on intermediate steps, creating a logical chain of reasoning. The specific type of mediate inference, syllogism, consists of three propositions and ensures that the conclusion necessarily follows from the given premises. Categorical syllogism, a subtype of syllogism, uses categorical propositions (A, E, I, and O) to draw conclusions about categories or classes. The significance of these concepts lies in their contributions to critical thinking, clear reasoning, and the systematic evaluation of arguments across various disciplines. Syllogism serves as a powerful tool for constructing persuasive arguments, analysing logical coherence, and making sound decisions. By employing the rules of syllogism, we can assess argument validity, identify fallacies, and enhance problem-solving abilities. Mediate inference and syllogism together enrich our understanding and application of logical reasoning, enabling us to form comprehensive understandings of complex arguments. The implications of these concepts extend to academic and real-world contexts, promoting sound decision-making and logical analysis. Apart from categorical syllogism, there are disjunctive and hypothetical syllogisms, which will be discussed in the next block.

Self-Assessment

1. What is mediate inference? Give examples.
2. What is a syllogism, and what is the structure of a syllogism?
3. What are the key differences between categorical syllogisms and other types of syllogisms?

Assignments

1. Explain the rules of a syllogism with examples.
2. List the common fallacies that may occur when the rules of syllogism are violated.
3. What are the rules of figures of a categorical syllogism? Provide proof.
4. Explain the difference between the mood and figure of a syllogism. Discuss different moods of categorical syllogism and provide examples of each mood.

Reference

- Bowie, G. (2004). *A Beginner's Guide to Logic.* Oxford University Press.
- Copi, I. M., & Cohen, C. (2017). *Introduction to Logic* (15th ed.). Routledge.
- Creighton, J. E., & Smart, J. J. C. (1973). An Introduction to Logic (2nd ed.). Routledge.
- Lemmon, E. J. (1965). *Beginning Logic*. Nelson.
- Sider, T. (2010). *Logic for Philosophy*. Oxford University Press.

Suggested Reading

- Hurley, P. J. (2016). *A Concise Introduction to Logic*. Cengage Learning.

Space for Learner Engagement for Objective Questions

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BLOCK 3
Mixed Syllogism

UNIT 1
Hypothetical syllogism

Learning Outcomes

After the completion of this unit, the learner will be able to

- understand what a mixed syllogism is and the varieties of mixed syllogisms
- know what hypothetical syllogism is
- detect the rules and fallacies of a syllogism and thereby evaluate the validity and invalidity of the hypothetical syllogisms
- breakdown complex statements and arguments into simpler components

Background

Syllogisms are key factors of deductive reasoning, where the conclusions are drawn from known premises. If the given premises are true and the syllogism is valid, then the conclusion carries the guarantee to be true. The history of syllogism can be traced back to the famous thinker Aristotle, who lived from 384-322 BCE. His contribution to syllogism and logic can be found in his prominent treatise on logic called 'Prior Analytics'. Syllogisms are essential for developing strong logical arguments, and fostering critical thinking skills. They nourish the ability to critically examine and understand the reasoning faculty, making one efficient regarding decision-making and communication. Syllogism enables people to deal with complex arguments by converting them into more convincing and manageable forms. This helps in analyzing the relation between the statements and drawing a perfect and accurate conclusion based on logic rather than mere emotions. Through the understanding of the rules of syllogism we will be able to detect the fallacies and can prevent us from deriving mistakes in the process of reasoning.

Keywords

Syllogism, Hypothetical Syllogism, Fallacies, Mixed Hypothetical Syllogism, Pure Hypothetical Syllogism.

Discussion

- Syllogism is a deductive argument

A syllogism is a deductive argument consisting of two premises and one conclusion. It is a kind of logical argument where deductive reasoning is used to arrive at a conclusion. Syllogisms are classified as categorical or non-categorical (conditional). Non-categorical syllogism or mixed syllogism is a mediate reasoning having two premises and a conclusion. But the propositions (premises and conclusion) involved are not categorical propositions. There are two prominent types of compound or mixed syllogisms. They are:

1. Hypothetical Syllogism
2. Disjunctive Syllogism

3.1.1 Hypothetical Syllogism

- Hypothetical proposition is of the form 'if- then'

A hypothetical syllogism is one in which one or all the propositions are hypothetical. They are compound propositions of the form where an 'if- then' relationship appears. For example, 'if there are signs of life on Mars, then the Mars Rover will find it' is a hypothetical proposition.

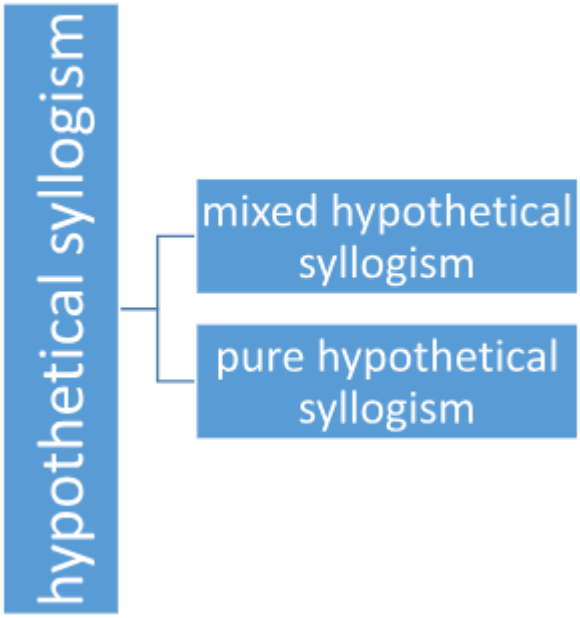
A conditional or hypothetical proposition contains two component propositions. The one following the 'if' is the *antecedent* and the one following the 'then' is the consequent. That is, if P implies Q, then P is the antecedent and Q is the *consequent.*

For example: If Michael Jackson is a great singer, then he is known as the King of Pop.

In this statement, 'Michael Jackson is a great singer' is the antecedent since it follows the 'if', and 'he is known as the King of Pop' is the consequent as it follows the 'then.'

Hypothetical syllogism is of two kinds.

1. Mixed hypothetical syllogism
2. Pure hypothetical syllogism.



3.1.2 Mixed hypothetical syllogism

- Mixed hypothetical syllogism has one hypothetical premise and one categorical premise

A syllogism having one conditional premise and one categorical premise is called a mixed hypothetical syllogism. It contains a hypothetical 'if, then' proposition as the major premise and other premises and conclusion are not conditional in nature. When one of the premises is conditional, the others either affirm or deny with either the antecedent or consequent of that conditional statement. For example,

If he is a criminal, then he should be punished

He is a criminal

Therefore, he should be punished

- The minor premise in this mixed hypothetical syllogism is the antecedent of the hypothetical proposition

It is a mixed hypothetical syllogism. Here, the major premise is a hypothetical proposition, and the minor premise and the conclusion are categorical in nature. In the above syllogism, 'he is a criminal' is the antecedent, and 'he should be punished' is consequent of the hypothetical proposition. The minor premise in this mixed hypothetical syllogism is the antecedent of the hypothetical proposition. There exist four possible forms of mixed hypothetical syllogism, of which two are valid and the other two are invalid.

- The conclusion of the mixed hypothetical syllogism is the consequent of the hypothetical major

3.1.2.1 Validity of mixed hypothetical syllogism

A mixed hypothetical syllogism can be said to be valid when it seems to follow the following conditions:

1. The major premise should be a hypothetical proposition;
2. The antecedent of the major premise is the minor premise of the mixed hypothetical syllogism;
3. The conclusion is the consequent of the major premise.

For a mixed hypothetical syllogism to be valid, it should obey these conditions.

A valid mixed hypothetical syllogism will be like:

1. If the government invests in renewable energy, then the carbon footprint can be reduced

   The government invests in renewable energy

   Therefore, the carbon footprint is reduced

2. If kids learn about body positivity, then body sham ing can be prevented

   The kids learn about body positivity

   Therefore, body shaming can be prevented

3. If he is apolitical, then he may refrain from partici pating in elections, community engagements, and other civic activities.

   He is apolitical

   Therefore, he may refrain from participating in elec

   tions, community engagements, and other civic activities.

4. If the investigation fails, then the criminal will es cape.

   The investigation fails.

   Therefore, the criminal will escape.

5. If Barack Obama ruled efficiently, then his citizens are content and happy.

   Barack Obama ruled efficiently.

   Therefore, his citizens are content and happy.

3.1.2.2 Kinds of Mixed Hypothetical Syllogism

- The minor premise of Modus Ponens affirms the antecedent of the major, and the conclusion affirms the consequent of the major

There are two valid forms of mixed hypothetical syllogism which are given special titles. They are:

1. Modus Ponens or Constructive Hypothetical Syllogism
2. Modus Tollens or Destructive Hypothetical Syllogism

In a mixed hypothetical syllogism, when the categorical premise affirms the antecedent of the conditional premise and the consequent is affirmed in the conclusion, this form of argument is termed as the affirmative mood or Modus Ponens (from the Latin *"ponere,"* meaning 'to affirm'). It is a valid form of deductive reasoning following the pattern: If P, then Q.

- P (the antecedent is true)
- Therefore, Q (the consequent is true)

$$\begin{array}{ll} p \supset q & \text{modus ponens (MP)} \\ \underline{p} & \\ Q & \end{array}$$

For example,

If people get accurate and age-appropriate information about reproductive anatomy, sexual health, and the various aspects of human sexuality (P), then sex education is essential (Q).

People get accurate and age-appropriate information about reproductive anatomy, sexual health, and the various aspects of human sexuality (P).

Therefore, sex education is essential (Q).

The invalid form of the valid modus *ponens* can be like this,

If Shakespeare wrote *Macbeth,* then Shakespeare was a great writer

Shakespeare was a great writer

Therefore, Shakespeare wrote *Macbeth.*

Here it is not a valid *modus ponens*, because the categorical premise affirms the consequent instead of the antecedent. Any argument of this form is said to commit the fallacy of affirming the consequent.

The other form of a valid mixed hypothetical syllogism is of the form,

If the coral reefs are saved, then the marine ecosystem is conserved

The marine ecosystem is not conserved

Therefore, the coral reefs are not saved.

- The minor premise of Modus Tollens negates the consequent of the major, and the conclusion denies the antecedent of the major

Here the categorical premise can be seen negating the consequent of the conditional (major) premise and the conclusion denies the antecedent of the major. Any argument of this form is said to be valid and it is called *Modus Tollens* (from the Latin t*ollere*, meaning "to deny"). It is a practical application of the axiom that if a proposition is true, then its contrapositive is also true. The form demonstrates the validity of the inference from P implies Q to the negative of Q entails the negation of P. Modus Tollens is a valid form of deductive reasoning of the pattern:

- If P, then Q
- Not Q (the consequent is false)
- Therefore, not P (the antecedent is false).

Example 1,

If she is lying (P), then we can prove it (Q)

We cannot prove it (not Q)

Therefore, she is not lying (not P)

Example 2,

If she is having a party today (P), she will be wearing a

gown (Q).

She is not wearing a gown (not Q)

Therefore, she is not having a party today (not P)

Example 3,

If plastic waste is recycled (P), then the environment will be saved (Q)

The environment is not being saved (not Q)

Therefore, plastic waste is not recycled (not P)

Example 4,

If the nucleus of an atom is split, it releases a massive amount of energy.

The nucleus is not releasing a massive amount of en ergy

Therefore, the nucleus of an atom is not split

Example 5,

If quantum physics is easy for you, then you are a theoretical physicist.

You are not a theoretical physicist

Therefore, quantum physics is not easy for you

Affirming the antecedent (Modus Ponens)	Denying the consequent (Modus Tollens)
If P, then Q P Therefore, Q	If P, then Q Not Q Therefore, not P

3.1.3 Pure hypothetical syllogism

In a pure hypothetical syllogism, both the premises and the conclusion are hypothetical or conditional statements. It takes the form:

- Let 'A' represent the antecedent (the 'if' part) of the major hypothetical proposition
- Let 'B' represent the consequent (the 'then' part) of the major hypothetical proposition
- Let 'B' represent the antecedent (the 'if' part) of the minor hypothetical proposition
- Let 'C' represent the consequent (the 'then') part of the minor hypothetical proposition

- A pure hypothetical syllogism involves propositions as conditional

Then, the pure hypothetical syllogism can be represented as,

If A, then B (major hypothetical premise)

If B, then C (minor hypothetical premise)

Therefore, if A, then C (conclusion).

For example,

1. If plant domestication goes back over 10,000 years, then early farmers surely did not use molecular genetic techniques to arrive at their results.

   If early farmers surely did not use molecular genetic techniques to arrive at their results, then they would not have any existing crop models to develop new ones.

   Therefore, if plant domestication goes back over 10,000 years, then they do not have any existing crop models to develop new ones.

2. If you are an artist, then you will feel melancholy

   If you feel melancholy, then your art will convey the pain

   ---

   Therefore, if you are an artist, then your art will convey the pain.

3. If cow is herbivore, then it will not eat meat

   If it will not eat meat, then it is not carnivore

   Therefore, if the cow is an herbivore, then it is not a carnivore

4. If I do not work hard, then I cannot achieve anything

   If I cannot achieve anything, then I will be disap pointed

   ---

   Therefore, if I do not work hard, then I will be disap pointed

5. If children like Mr. Bean, then they will laugh

   If they will laugh, then they are happy

   Therefore, if children like Mr. Bean, then they are happy

6. If Sam gets the job, then he earns money

   If he earns money, then he will be rich

   Therefore, if Sam gets the job, then he will be rich

The validity of a pure hypothetical syllogism can be based on how the statements are perfect like a chain. A pure hypothetical syllogism is valid when,

i. The antecedent of the major premise is the same as the antecedent of the conclusion.

ii. The consequent of the minor premise is the same as the consequent of the conclusion.

For example,

If the lion is a female, then it is an animal.

If the lion is a male, then it is an animal.

Therefore, if the lion is a female, then it is a male.

Here the premises are true, but the conclusion is not logically

derived since the statements are not linked properly.

iii. In a pure hypothetical syllogism, the conclusion should not have any common terms with the premises. Instead, the conclusion should consist of an antecedent from the major premise and the consequent of the minor premise.

Any of the following arguments is true:

- $p \supset q$ Pure Hypothetical Syllogism (HS)

  $q \supset r$

  $p \supset r$

- $p \supset q$ Modus Tollens (MT)

  $\sim q$

  $\sim P$

- $p \supset q$ Modus Ponens (MP)

  p

  ---

  q

Any arguments having either of the following forms is invalid:

- $p \supset q$ Affirming the Consequent (AC)

  q

  ---

  p

- $p \supset q$ Denying the Antecedent (DA)

  $\sim p$

  $\sim q$

Summarized Overview

In logic and reasoning, mixed hypothetical syllogisms are crucial because they help to draw conclusions based on particular circumstances and categorical facts. They are frequently employed in many different disciplines, such as physics, maths, and daily decision-making. Hypothetical syllogisms are 'if-then' statements where we derive the conclusion from true conditional premises. The rules and fallacies of the hypothetical syllogism help the reader to effectively analyse and derive a valid conclusion. The truth table for a hypothetical syllogism does not exist. But as truth tables deal with conditional statements (if-then statements) rather than logical connectives, they cannot be applied to hypothetical syllogisms. In hypothetical syllogisms, a conclusion is reached by evaluating the logical connections between two or more conditional statements, or premises. They employ a certain framework and deductive reasoning to ascertain the validity of the conclusion in light of the provided premises. Analysing the antecedents and consequents of conditional assertions and searching for legitimate patterns of inference are necessary steps in evaluating hypothetical syllogisms. The main goal is to use the syllogism's logical framework to determine if the conclusion inevitably follows from the premises. This procedure entails following the rules of sound deductive reasoning and comprehending the many kinds of hypothetical syllogisms, such as pure hypothetical and mixed hypothetical syllogisms.

Self-Assessment

1. What is hypothetical syllogism and what are the varieties?
2. What are the rules and fallacies of a hypothetical syllogism?
3. What is the difference between Modus Ponens and Modus Tollens?

AssignmenWts

1. Make a comprehensive note of hypothetical syllogism, highlighting its classifications with examples.
2. Briefly discuss the different types of mixed hypothetical syllogism, with symbolic representation and examples.

Reference

- Copi, I. M., & Cohen, C. (2017). *Introduction to Logic* (15th ed.). Routledge.
- Bowie, G. (2004). *A Beginner's Guide to Logic.* Oxford University Press.
- Creighton, J. E., & Smart, J. J. C. (1973). *An Introduction to Logic* (2nd ed.). Routledge.

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UNIT 2
Disjunctive syllogism: Rules and Fallacies

Learning Outcomes

After the completion of this unit, the learner will be able to:

- understand what a disjunctive syllogism is
- recognize the fallacious reasoning involving the 'or' operator
- practically apply the benefits of disjunctive syllogism since in real life we are offered multiple choices and conditions.

Background

Since critical analysis and logical reasoning are very crucial in academics like mathematics, law, philosophy, and so on, disjunctive syllogism is beneficial. Understanding disjunctive syllogism is the very foundation of logical reasoning. So, it is effective in the way that it builds a strong foundation in logical reasoning. In everyday life, when faced with choices or alternatives, people often use disjunctive reasoning to eliminate options and arrive at decisions. This form of reasoning is also applied in solving logical puzzles and games that involve making choices or ruling out possibilities. In legal settings and argumentation, a disjunctive syllogism can be employed to confirm or eliminate certain possibilities, which is crucial for building persuasive arguments or reaching legal judgments. Moreover, disjunctive syllogism serves as a foundational concept in logic, forming the basis for more complex forms of reasoning, and is an essential building block in the study of logical systems.

Keywords

Disjunctive Syllogism, Fallacies, Alternative Proposition

Discussion

3.2.1 Disjunctive Syllogism

Syllogisms are named after the kind of propositions used in them. Disjunctive syllogism is a form of deductive reasoning that deals with disjunctive propositions, which are connected with the word "or". The major premise of a disjunctive syllogism consists of a disjunctive proposition and the minor premise and conclusion consist of categorical propositions. A disjunctive proposition can also be called an alternative proposition. The valid argument form of disjunctive syllogism is;

- A disjunctive proposition is a compound proposition joined by the connective 'either-or'

Either Lisa goes to the library or Lisa will attend the class

Lisa does not go to the library

Therefore, Lisa will attend the class

This is an example of disjunctive syllogism. 'Either Lisa goes to the library or Lisa will attend the class' is a disjunctive proposition. It is a compound proposition having two categorical propositions, 'Lisa goes to the library' and 'Lisa will attend the class', which are joined by 'either-or'. So, a disjunctive proposition consists of two component propositions, which are its disjuncts. In a disjunctive syllogism, if one of the components is false, then the other is true.

- The components of the disjunctive proposition are 'disjuncts'

Symbolically, the formation of Disjunctive syllogism is as follows:

- Either p v q

  Not p (~p)

  Therefore, q
- Either p v q

  Not q (~q)

  Therefore, p

A disjunctive proposition is said to be valid when it follows these conditions:

- Among the two premises, the first one is a disjunctive proposition.

- In the next premise the negation or contradiction of either of the two disjuncts occur
- The remaining disjunct is asserted in the conclusion since the other disjunct is negated already.

For example,

Either Robert is a hosteler or a day scholar

Robert is not a hosteler

Therefore, he is a day scholar

Here the propositions follow all the necessary conditions to be valid. Hence it is a valid disjunctive syllogism.

The validity of this form can be checked by the truth table.

p	q	pvq	~p	Q
T	T	T	F	T
T	F	T	F	F
F	T	T	T	T
F	F	F	T	F

From this table, we can see that when pvq is true and

~q is true then the conclusion p is true. So, whenever p or q is true and not p (~p) is also true, then q is true. For example,

Either Cairo or Namibia is the capital of Egypt	C v N
Namibia is not the capital of Egypt	~N
Therefore, Cairo is the capital of Egypt	∴ C

The general rule is that among the two alternatives, one should be negated in the premise and the leftover alternative of the major premise is affirmed in the conclusion. One of the two alternatives is eliminated in the premise so that the other is accepted as true. This technique can be called the "method of elimination".

There exists the invalid form of disjunctive syllogism too.

Let us look at an example,

Either Transformers is science fiction or it is an action movie.

It is an action movie

Therefore, it is not science fiction.

Here the symbolic representation can be,

Either p v q
q

Therefore, not p

Here in the above proposition, we can see that the conclusion does not necessarily follow from the premises. The Transformers (movie) can be science fiction as well as an action movie. In the case of a valid disjunctive syllogism, if one disjunct is denied in the minor, then the other is affirmed in the conclusion. It must be mutually exclusive. But, in this example, the alternatives provided are not exclusive, one disjunct being true does not deny the possibility of the other disjunct being true. Since the conclusion here is not followed properly from the premise, it is an invalid disjunctive syllogism. So, for a disjunctive syllogism to be invalid, the conditions are as follows,

- In a disjunctive syllogism, both of the disjuncts cannot be false together

- The first premise is a disjunctive syllogism
- One of the two disjuncts in the first premise is affirmed in the second premise.
- In the conclusion the other disjunct of the first premise is denied.

The invalid forms of disjunctive syllogism can be symbolically represented as,

1. Either p or q
   p

Therefore ~q

2. Either p or q

q

Therefore,~p

So, a disjunctive syllogism is valid only when the minor premise denies one of the disjuncts of the disjunctive proposition and the conclusion affirms the other disjunct.

Summarized Overview

A disjunctive syllogism is a simple way of making choices. It helps us decide between two options by saying that one of them must be true while the other is not. Disjunctive syllogisms are significant because they make our decision-making logical and clear. They are different from other syllogisms, like categorical syllogisms, which deal with relationships between categories; disjunctive syllogism is all about choosing between alternatives.

Self-Assessment

1. Identify whether the given conditional (non- categorical) syllogisms are valid:

- Either England is a better place to live or the people are dangerous

  England is a better place to live

  Therefore, the people are not dangerous.

- Either the festival is a big success or the coordinators are a failure

  The coordinators are a failure

  Therefore, the festival is a big success.

- Either sunscreen lotion will protect your skin or you will get an allergic reaction

  You will not get an allergic reaction

  Therefore, sunscreen will protect your skin.

- Either the hotel is expensive or it is cheap

  It is cheap

  Therefore, the hotel is not expensive

- If he comes, either I will leave or I will hide.

  I did not leave

  Therefore, I hide.

2. What is a disjunctive syllogism and its fallacy?

Assignments

1. Make a note of disjunctive syllogism and explain how they are different from hypothetical syllogisms. Provide examples of each type of syllogism.
2. Discuss the validity of disjunctive syllogisms. What are the conditions that must be met for a disjunctive syllogism to be considered valid? Give sym bolic representations of valid disjunctive syllogisms with examples.

Reference

- Copi, I. M., & Cohen, C. (2017). *Introduction to Logic* (15th ed.). Routledge.
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UNIT 3
Dilemma

Learning Outcomes

After the completion of this unit, the learner will be able to:

- define the standard form of a dilemma in logic, understanding its key components including major premise, minor premise, and conclusion.
- understand the dilemma which is logically sound or invalid
- analyse compound propositions within a dilemma, recognising the conditional and disjunctive nature of the major premise
- distinguish between the two valid forms of a dilemma: constructive dilemma and destructive dilemma

Background

Generally speaking, a dilemma is a situation where two or more alternatives are present and we have to choose one. The word dilemma is derived from the Greek word *dilemma* (di 'twice' + lemma 'premise'). It is a term used in logic and in rhetoric where the opponent is left with two alternatives which are unfavorable too. We can say a person is in a dilemma when he is presented with two options. People use the word dilemma to express their unpleasant situation when trapped between alternatives. Logic, as the study of reasoning and argumentation, unveils the details of decision-making processes and the complexities that arise when confronted with conflicting propositions. One interesting facet of logical analysis is the examination of dilemmas, situations where individuals or systems find themselves caught between two equally compelling but mutually exclusive alternatives. Dilemmas serve as fertile ground for exploring the conditional and disjunctive nature of logical propositions, forming a cornerstone in the study of complex reasoning.

Keywords

Dilemma, Constructive Dilemma, Destructive Dilemma

Discussion

3.3.1 Dilemma

- Dilemma is both conditional and disjunctive

The standard form of a dilemma can be presented with three propositions out of which the two premises lead to the third, the conclusion. The major premise here consists of two hypothetical propositions, the minor premise is a disjunctive proposition and the conclusion is either a categorical proposition or a disjunctive proposition. This is why the dilemma is perceived as non-categorical, from the perspective of logic. In short, all three propositions are compound propositions. One of the two propositions is a conjunction of two speculative assertions, and the other is usually a disjunctive one. The conclusion derived from these two premises will usually be a disjunctive proposition. Dilemma is both conditional and disjunctive. The major premise is a compound conditional proposition consisting of two or more simple conditional propositions connected by 'and' or its equivalent.

For example,

If A then B, and if C then D

Either A or C

Therefore, B or D

The minor premise is a disjunctive proposition that alternatively posits the antecedents or the consequents.

The two alternatives presented in the conclusion of a dilemma are known as the *two horns of the dilemma.* (italics) Because it refers to a situation where a person is faced with equally challenging or undesirable options, causing it difficult to make a decision.

There are two valid forms of a dilemma, they are :

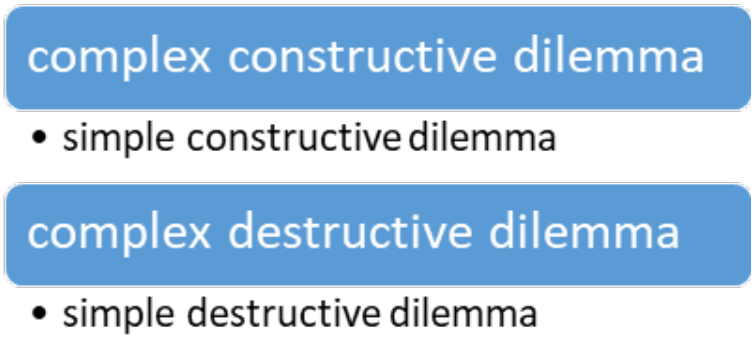
- Constructive Dilemma and
- Destructive Dilemma

A constructive dilemma is one in which the minor premise, which is a disjunctive proposition, affirms the antecedents of

the major premise.

A destructive dilemma is one in which the minor premise denies the consequents of the major premise.

A constructive dilemma can be subdivided into complex constructive dilemma and simple constructive dilemma depending upon the type of conclusion it provides. The destructive dilemma can be subdivided into complex destructive dilemma and simple destructive dilemma depending upon the type of conclusion it provides.



3.3.1.1 Complex Constructive Dilemma

- minor premise affirming the antecedent disjunctively, and conclusion affirming the consequent disjunctively.

A complex constructive dilemma is in the form of syllogism in which the major premise is compound, consisting of two or more hypothetical propositions. The minor is a disjunctive proposition, where the components consist of the antecedents of the major, and the conclusion is a disjunctive syllogism where the components are the consequents of the major. It is the inference that if P implies Q and R implies S and either P or R is true, then Q or S has to be true.

Any argument that has the form of a constructive dilemma is a valid argument, for example:

P1: If we choose plastic carry bags, then we increase the risk of soil degradation; but if we choose paper bags, then we increase the risk of cutting down more trees.

P2: We must choose either plastic carry bags or paper bags

Therefore, we either increase the risk of soil degradation or increase the risk of cutting down more trees.

Complex Constructive dilemma (CD)

P1: (p⊃q). (r⊃s)

P2: p v r

Therefore: q v s

For example:

P1: If Russia wages war over Ukraine to expand its territory, then it is a colonial country and if it wages war for only killing the people, then it supports ethnic cleansing

P2: Russia wages war over Ukraine to expand its territory or for only killing the people

Therefore, it is a colonial country or it supports ethnic cleansing

3.3.1.2 Simple Constructive Dilemma

- minor premise affirming the antecedents disjunctively, and a simple conclusion affirming the same consequent

In a simple constructive dilemma (SCD), both hypothetical propositions have the same consequents, and the antecedents are different. These antecedents are affirmed disjunctively in the minor premise and the conclusion is, where the consequent is affirmed. If any antecedent is true, the consequent must be true. The conclusion is a simple proposition, since there is only one consequent. This can be represented as follows:

Simple Constructive Dilemma (SCD)

P1: (p⊃q) . (r⊃q)

P2: p v r

Therefore, q

An example of this can be represented through the reflections of a thief.

P1: If I keep the stolen money, I will be caught and if I run away with the money, I will be caught.

P2: I must either keep the stolen money or run away with the money.

Therefore, I will be caught.

3.3.1.3 Complex Destructive Dilemma

In a complex destructive dilemma (CDD) a slight difference is present. The difference is that, here major premises are two disjunctive propositions, and the minor is the contradic-

- Disjunctive minor denies the antecedents of the major, and the disjunctive conclusion denies the consequents of the major.

tories of the consequents of the major, and the conclusion negates the antecedents of respective propositions in a disjunctive way. The form can be represented as:

complex destructive dilemma (CDD)

P1: $(p \supset q) . (r \supset s)$

P2: $\sim q \vee \sim s$

Therefore, $\sim p \vee \sim r$

For example:

P1: If it is sunny, then you will be sweaty and if it is cold, then you will shiver.

P2: Either you are not sweaty or you are not shivering.

Therefore, either it is not sunny or it is not cold.

3.3.1.4 Simple Destructive Dilemma

- consequents of the major premise are denied in the disjunctive minor, and the same antecedent of the major is denied in the simple conclusion

The simple destructive dilemma is different only in the aspect that the conclusion is a simple proposition and negative. The minor premise is similar in structure to that of the minor premise of a complex destructive dilemma (CDD). The conditional premise infers more than one consequent from the same antecedent. The form is as follows:

simple destructive dilemma (SDD)

P1: $(p \supset q) . (p \supset r)$

P2: $\sim q \vee \sim r$

Therefore: $\sim p$

An example of this can be represented through:

P1: If she wants to get the job, she must be dedicated and she should be intelligent

P2: Either she is not dedicated or she is not intelligent

Therefore, she will not get the job.

3.3.2 Refuting Constructive and Destructive Dilemmas

The argument forms of constructive and destructive dilemmas occur usually in public debates. These forms are used to put the opponent in an unpleasant condition thereby trapping him/her to choose between the alternatives. Since both

- When there are more than two alternatives, it is called, escaped between the horns of the dilemma

forms are valid, the direct mode available to the opponent to defend himself is to show that the dilemma is unsound. This can be done by proving any one of the premises is false. If the conjunctive premise which is also called the "horns of the dilemma" is proved to be false, then the opponent is said to have "grasped the dilemma by the horns". This is possible by proving one of the conditional statements is false. There exists another way for the opponent to defend himself and to show that the dilemma is unsound; it is the way of proving the disjunctive premise as false. This is said to be known as "escaped between the horns of the dilemma". This second strategy includes the method of finding a third alternative which excludes the two given in the disjunctive premise. If the opponent is able to find such a third alternative, then he succeeds in proving the disjunctive alternatives as false.

There are two ways we can refute or overcome the dilemma, either through a logical approach or an informal one.

3.3.2.1 Escaping between the horns of a dilemma

- Dilemma is compared to a bull and its alternatives with the horns of the bull

The first two consequences described may not be comprehensive or inclusive. If it is possible to demonstrate that they are insufficient, we can steer clear of conflict. This is referred to as "escape from the dilemma's horns." Noteworthy is the fact that even the suggestion of a third consequence does not necessarily imply that this new consequence is true. In other words, the new result is also speculative. The dilemma is compared to a bull and its alternatives with the horns of the bull. If both the alternatives are false, the disjunctive proposition (the minor premise of the dilemma) can be shown as false.

For example:

If a student is fond of learning, then she needs no stimulus, and if she dislikes learning, no stimulus will be of any use.

A student is either fond of learning or dislikes learning

Therefore, a stimulus is either needless or of no use (conclusion)

Here, the disjunctive minor premise makes an improper assumption that a student is either fond of learning or dislikes it. But these are the only two alternatives, since there are many students who are neither fond of learning nor dislike it and for them, a stimulus is desirable.

Here the alternatives are not mutually exhaustive. Arguing and showing that there are more alternatives available is

called escaping between the horns.

3.3.2.2 Taking the dilemma by the horns

In this way of avoiding a dilemma, an effort is made to refute the conjoined hypothetical assertions. When the antecedent and the negative of the consequent are accepted, the hypothetical proposition is refuted.

Consider the example,

If we encourage competition, we will have no peace, and if we do not encourage competition, we will make no progress (Major Premise)

We must either encourage competition or not encourage competition. (Minor Premise)

Therefore, we will either have no peace or make no progress

Here the minor premise is a tautology (p v ~p). Therefore, the dilemma cannot be refuted by showing a 'false dichotomy'. Hence, the dilemma is refuted by pointing out the errors in the major premise. If we represent the major premise as 'If p then q and if r then s', 'p' and 'r' are antecedents, and 'q' and 's' are consequents. The dilemma is proved unsound either by showing that either 'q' does not follow from 'p' or 's' does not follow from 'r'. This method is called 'taking the dilemma by the horns' or sometimes 'grasped by the horns'. In the example cited above, 'we will have no peace' does not follow from 'we encourage competition'. Healthy completion could be encouraged, which does not affect one's peace of mind. We can also show that 'we will make no progress' does not follow from the antecedent 'we do not encourage competition'.

- 'Taking the dilemma by the horns' is also called 'grasped by the horns'

3.3.2.3 Rebuttal of dilemma

In order to make a dilemma ineffective when one presents a counter-dilemma, it is known as a rebuttal of a dilemma. This is more a rhetorical device than a logical one. Proving the given dilemma invalid or unsound by either attacking the minor premise or the major premise is known as a refutation of the dilemma, which is a logical device.

The rebutting of the dilemma can be represented through the example: (I)

P1: If the musician is strict, then he is disliked among the singers

If the musician is not strict, then the producer does not pay him

- Presenting a counter-dilemma to weaken the original is called a 'rebuttal of dilemma'

P2: The musician is strict or he is not strict

Therefore, the musician is disliked by the singers or the producer does not pay him.

P1: $(p \supset q) . (\sim p \sim r)$

P2: $p \vee \sim p$

Therefore, $q \vee \sim r$

The counter dilemma for this can be said to be, (II)

P1: If the musician is not strict, then he is liked among the singers and

if he is strict, then the producer will pay him.

P2: The musician is not strict or he is strict

Therefore, the musician is liked by the singers or the producer will pay him.

$(\sim p \supset \sim q). (p \supset r)$

$\sim p \vee p$

Therefore, $\sim q \vee r$

In the rebuttal of the dilemma, the minor premise remains the same. There is a change in the major premise, hence there is a change in the conclusion. Rebuttal is a rhetorical device that may be logically as incorrect as the given dilemma. But it is an effective device that turns the opponent's argument against himself. In public debates and also in persuading others, rebutting the dilemma seems to be a smart weapon.

Summarized Overview

A dilemma is a type of argument in which an opponent is presented with two or more mutually exclusive choices, each of which leads to unfavorable outcomes. Dilemmas are often used to stimulate an opponent to consider a different perspective or to make a difficult decision. Dilemmas carry significant importance both at the individual and societal levels, primarily due to their capacity to trigger complex cognitive processes that influence decision-making. By presenting us with equally unfavorable options, dilemmas effectively illuminate our fundamental values and ethical foundations. They hold critical positions in philosophical, legal, and ethical discussions, providing a framework for analyzing decision outcomes and contributing to the shaping of societal norms and values. Be it within personal narratives or broader societal concerns, dilemmas emphasize the need for careful and rational consideration of choices when faced with demanding circumstances.

Self-Assessment

1. Define dilemma. Explain with examples.
2. Distinguish between 'rebuttal' and 'refutation' of a dilemma.
3. Identify the following dilemmas as either constructive or destructive.

- If we build an outhouse by the banks of the river, then it will be struck by floods; and if we build the outhouse on the hilltop, then it will be hit by lightning. Since we must build the outhouse by the banks of the river or on the hilltop, the outhouse will either be struck by flood or hit by lightning.
- If the psychiatrists respect the confidentiality of the clients, then they will not disclose the history of abuse they faced to the authorities; but if they have any concern for the justice of the patients, then they will disclose it to the authorities. Psychiatrists must either disclose or not disclose the history of abuse faced by the clients. Therefore, psychiatrists either have no respect for their clients' right to confidentiality or no concern for the justice of the clients.
- If she wants to save the puppy in the water, then she will fall down; but if she walks away, then the puppy will drown and die. She must either save the puppy or walk away. Therefore, either she will fall down or the puppy will drown and die.
- If you spend the days working hard, then you will be able to be the best performer of the month; but if you do not spend the days working hard, then you will fail miserably. You must spend the days working hard or not working hard. Therefore, you will either be the best performer of the month or you will fail miserably.
- If you leave your home now, you will be independent but live in poverty. If you stay with your family, you will be under curfew. Hence you must either leave your home or stay with them. Therefore, you will either live independently in poverty or with your family under curfew.

4. What is meant by 'escaping between the horns'. Illustrate.

Assignments

- Write down a brief note on dilemma and the different classifications with its symbolic representations.
- Make a short note on rebuttal of dilemma.

Reference

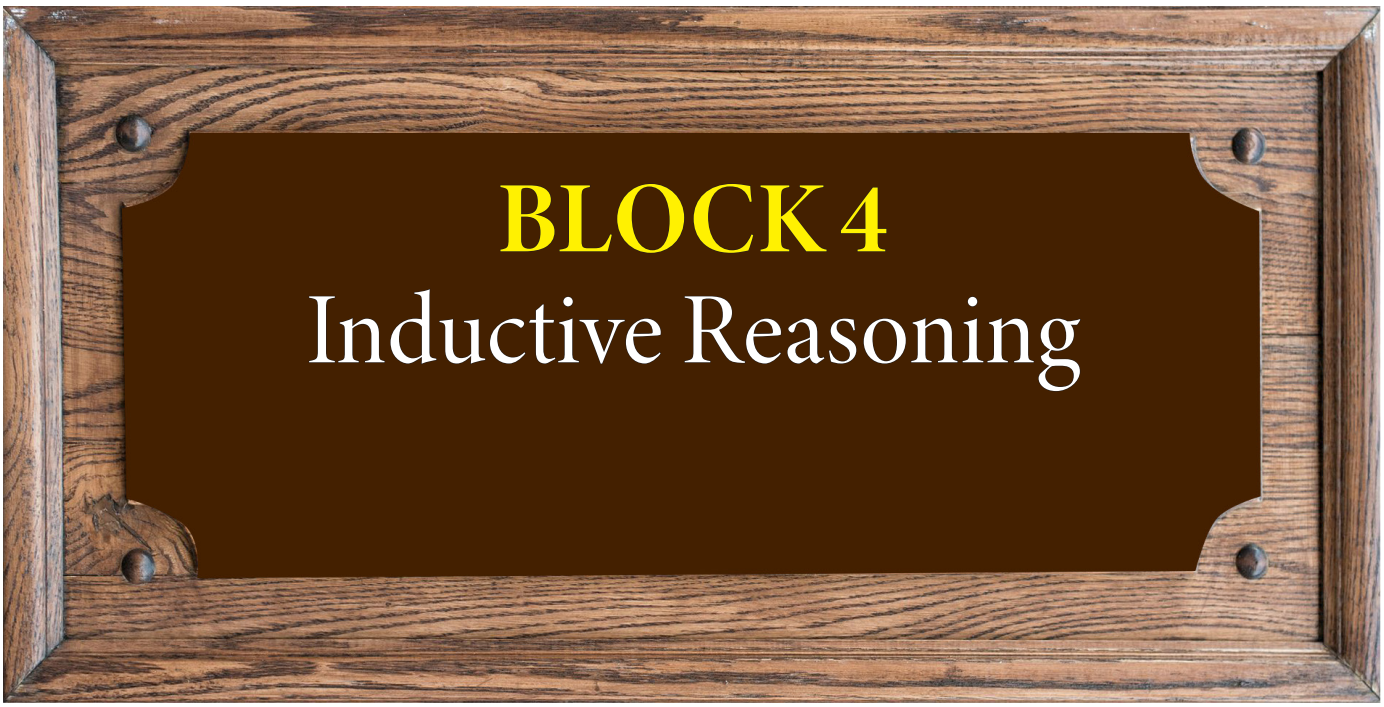
- Copi, I. M., & Cohen, C. (2017). *Introduction to Logic* (15th ed.). Routledge.
- Bowie, G. (2004). *A Beginner's Guide to Logic.* Oxford University Press.
- Creighton, J. E., & Smart, J. J. C. (1973). *An Introduction to Logic* (2nd ed.). Routledge.

Suggested Reading

- Hurley, P. J. (2014). *A Concise Introduction to Logic* (12th ed.). Cengage Learning.
- Smith, H. (2013). *An Introduction to Formal Logic* (3rd ed.). Cambridge University Press.

Space for Learner Engagement for Objective Questions

Learners are encouraged to develop objective questions based on the content in the paragraph as a sign of their comprehension of the content. The Learners may reflect on the recap bullets and relate their understanding with the narrative in order to frame objective questions from the given text. The University expects that 1 - 2 questions are developed for each paragraph. The space given below can be used for listing the questions.


BLOCK 4
Inductive Reasoning

UNIT 1
Induction

Learning Outcomes

After the completion of this unit, the learner will be able to:

- understand the basics of inductive reasoning and grasp the concept of making generalisations based on patterns observed in a limited set of instances.
- differentiate between inductive and deductive reasoning.
- develop skills to recognize patterns and trends within data or observations.
- assess the strength of the argument based on the relevance, representativeness, and sufficiency of the observed instances.
- understand the role of inductive reasoning in scientific research.

Background

As we discussed earlier, deductive reasoning derives specific conclusions from one or more general premises. But induction takes a different path. It begins with specific, particular observations or evidence and aims to derive broader, more general conclusions. Induction is useful in various aspects of life and reasoning. In science, for instance, we use induction to form hypotheses and theories based on repeated observations and experiments. It helps us make predictions about natural phenomena and guides further research. In everyday life, we rely on induction to make practical decisions, such as assuming that the sun will rise tomorrow because it has risen every day in the past. Inductive reasoning is particularly valuable when exploring patterns, making predictions, or formulating hypotheses based on empirical data. It provides a flexible approach to reasoning, where the conclusions drawn are considered probable but not guaranteed to be true. Induction, though not infallible, is a powerful method for making sense of the world when we lack absolute certainty, allowing us to navigate uncertainty with reasonable confidence.

Keywords

Inductive Leap, Postulates of Induction, Analogy, Hypothesis

Discussion

Reasoning refers to the mental process of drawing conclusions or making inferences based on available information, evidence, or principles. It involves logical thinking and the ability to analyse, evaluate, and solve problems. Reasoning allows us to make sense of the world, make informed decisions, and form beliefs or judgments.

- Like deduction, induction is a form of reasoning

Like deduction, induction is a form of reasoning and a type of inference in which a conclusion is drawn from some observed instances about the unobserved instances of the same kind. Though the premises do not necessarily imply the conclusion in induction, the premises are a good reason for drawing the conclusion. No empirical science, natural or social study which aims to describe nature, world, or society, can do without induction.

Deductive reasoning involves drawing specific conclusions from general principles or premises. It follows a top-down approach where the conclusions are necessarily true if the premises are true. For example:

Premise 1 : All mammals are warm-blooded.

Premise 2 : Whale is a mammal.

Conclusion : Therefore, whale is warm-blooded.

On the other hand, inductive reasoning involves drawing general conclusions or patterns based on specific observations or examples. It follows a bottom-up approach where the conclusions are likely to be true, but not necessarily guaranteed. For example:

Observation 1 : The apple I ate yesterday was sweet

Observation 2 : The apple I ate today was sweet

Observation 3 : The apple I ate last week was sweet

Conclusion : Therefore, all apples are sweet.

Inductive reasoning is based on probability and can be strengthened or weakened by additional evidence. The most

acceptable difference between deduction and induction is that deductive is 'necessary' or demonstrative inference, whereas inductive inferences are merely 'probable'. While the conclusion is 'claimed to follow' necessarily from the premises in deductive inference, in inductive inference, the conclusion is not 'claimed to follow' necessarily from the evidence, but only with some degree of probability.

- Inductive inference is probable

The formal sciences like pure Mathematics and formal logic are often described as deductive in nature. The reasoning that goes on in pure mathematics and formal sciences is purely deductive. The empirical sciences such as physics, chemistry, biology, etc, and social sciences such as political science, economics, history, and psychology, etc are often described as inductive because the reasoning involved in them is inductive in nature. However, we must note that the empirical sciences, whether natural or social, are not purely inductive; deductive reasoning also occurs in them.

- Empirical sciences are primarily inductive, but they also incorporate deductive reasoning in their methodologies.

What exactly is meant by induction? According to J S Mill, "Induction is the name given to the operation of the mind by which we infer that what we know to be true in particular case or cases, will be true in any other case or cases of a similar kind..." In other words, it is a process by which we conclude that what is true of certain individuals of a class is true of the whole class, or what is true at certain times will be true in similar circumstances at all times.

- Induction infers general principles from specific instances.

4.1.1 Problem of Induction

The problem of induction is the problem of getting general principles out of particular facts. The most relevant question that we confront here is 'how can we jump from a few particulars to universal?

How are the premises proved?

How to get the correct premises?

The problem of induction lies in solving these questions. It is induction that can give correct universal premises, in the absence of which all syllogistic reasoning is impossible. Hence 'how' to get correct universal premises is the problem of induction. The whole of induction is an attempt to answer the question 'How are the universal propositions discovered and formulated?' It is experience that gives us general propositions and it is experience again that guarantees their truth. In experience, we always observe particular instances. Hence, induction starts with particular instances. But to get a universal

proposition, induction does not examine all the particular instances connected with that law. For example, after examining a few cases of men's death, it passes on to a general statement that 'All men are mortal'. We say that what is true of some of the observed instances, is true of the whole class. This passage from a few instances to all instances, from the known to the unknown instances, from the observed to unobserved instances of a class is technically called 'an inductive leap'. Then there arises a problem of how we can justify this conclusion as one is not examining all cases related to this. The solution is to be found in two evident universal principles called the postulates of Induction, namely:

- The problem of induction centers on 'inductive leap'

1. Law of uniformity of nature.
2. Law of universal causation

1. Law of uniformity of nature - The law of uniformity of nature broadly states that if a certain phenomenon behaves or acts in a certain manner in the past, then in the future the same phenomenon will behave exactly in the same way. If water quenches our thirst or fire burns us, then in the future water will quench our thirst and fire will burn us too; though it is not rational to believe so, it is certainly reasonable to do so. Nature is uniform in her ways. That means the same cause produces the same effect. There is uniformity, regularity, and fixity in the behaviour of nature. Creighton defines uniformity of nature thus: "Things of the same nature produce under the same conditions, the same kinds of effects".

- The future events will resemble the past due to the consistent behaviour of natural phenomena

2. Law of universal causation - The law of causation tells us that every event has a cause. Whatever happens in this world must have a sufficient cause. Every event is due to an agency that has produced it. Everything that has a beginning must also have a cause to account for it. Suppose a girl passes the examination; we say there is a cause, namely that she has studied. So, study is the cause, and passing the examination is the effect. Cause goes before the effect. Only because she has studied well, that she passes the examination. The connection between cause and effect is called causal connection. A causal connection exists between the prior phenomena viewed as a cause and the posterior phenomena viewed as an effect.

- Law of causation says, every event has a cause.

Causal phenomena do not exist in one single instance. Cause is the totality of conditions of which the effect invariably and unconditionally follows. In the above example, 'study' is not the only cause of passing the examination. But the effect depends on the totality of conditions, namely her intellect, health, memory power, etc. A dull girl who failed the

examination might also have studied. So, cause consists of the totality of conditions. This causal connection pervades the whole universe. Everything happens according to this whole causal connection. That is why we say that the universe is a system of interrelated parts. Moreover, the same cause produces the same effect. If the combination of hydrogen and oxygen produces water today, it will be so always and everywhere. This is what is meant by saying that the same cause produces the same effect.

- Cause is the totality of conditions

The law of causation involves the uniformity of nature. Causation states that there is a necessary connection between prior phenomena viewed as a cause and posterior phenomena viewed as an effect. If the same cause does not produce the same effect, then, the prior phenomena is not the cause of the effect.

4.1.2 Observation and Experiment

Induction is the process of establishing universal law from particular facts. It must begin with the collection of facts. And it is through observation and experiment we collect facts which are necessary for induction. So, observation and experiments are the material grounds for induction. Inductive reasoning is guaranteed by postulates of induction and its material truth is guaranteed by observation and experiment. Facts are essential for every stage of induction. So, observation plays an important role throughout inductive reasoning. When we collect and describe the facts, our mind suggests certain probable explanations or hypotheses about the cause of the phenomenon. Verification of the hypothesis also requires facts with which the hypothesis is concerned. The proof of the hypothesis, too, needs facts to confirm the verified hypothesis.

- Observation and experiments are the material grounds for induction

Observation is the process of collecting particular facts and determining their nature for the purpose of science. Observation literally means to keep a thing before the mind. It is a process of looking at things with the purpose of determining as accurately as possible their nature. It is a deliberate or attentive perception of a phenomenon presented by nature like we observe eclipses, storms, comets, etc. Observation requires the application of our physical as well as intellectual faculties to the accurate description of natural phenomena. As Creighton said, facts do not pass over ready-made into the mind. The mind has to react to our sensations and interpret them. It is the mind of the human beings that is the true observer, though no observation is possible without the aid of the senses. Observation is not a pure sense activity, a passive reception of

- Observation is the process of collecting particular facts

facts through the senses; it is not a loose, vacant, and aimless gazing at things in nature, whereas experiment is the process of collecting facts that are artificially produced by the human beings themselves.

An experiment is an observation under artificial or controlled conditions. When a comet appears, we merely observe; but when we separate oxygen and hydrogen from water by electrolysis, we are said to experiment. Control of conditions is the distinguishing mark of an experiment. While observation is a regulated perception of natural events under natural conditions, an experiment is the artificial reproduction of events under conditions pre-arranged by ourselves. There is no essential difference between observation and experiment, no real opposition between these two methods of getting at facts. They differ only in degree and not in kind. Experiments involve observation; they help and end in observation.

- The experiment is carried out under artificially controlled conditions

4.1.2.1 Fallacies of Observation

There are several difficulties in the way of sound observation. The complexity of the phenomenon is a great difficulty for the observer. The observer has to isolate the phenomenon in question from the tangle of irrelevant circumstances in the midst of which it happens. When we want to study comets, they may occur when clouds prevent our observation. Sometimes observation must be completed within a brief time when nature is pleased to present us with the phenomenon. If we are not alert, we may be taken by surprise and all opportunities for studying the phenomenon may be lost.

- In observation, we must focus on the key factor and be vigilant to catch rare events on time

Our human faculties are limited in their capacity to work. Because of our weakness, constant attention becomes difficult, and thus distractions spoil our observation. And our likes and dislikes, our pet theories, and our pride and prejudice vitiate our observation. Frequently, there arises confusion between facts and our unconscious inferences about the facts. We confuse the facts with fancies. On account of these difficulties, errors may creep in while we collect facts. These errors are mainly non-observation and mal-observation.

- Observation errors, distractions, biases, and subjective inferences, can lead to non-observation and mal-observation.

4.1.2.2 Fallacy of Non-observation

- The fallacy of non-observation occurs when overlooks or neglects the important aspects of a phenomenon

It means failure to observe something that should have been observed in connection with the phenomenon in question. It is a negative fallacy or a fallacy of omission. An observer has in her/his mind a purpose or a theory in a general way while she/he collects the data or facts for the inductive enquiry. It is

the human tendency to observe the instances which support the preconceived theory and to neglect or overlook contrary instances. The fallacy of non-observation arises either due to prejudices or due to the complexity of the phenomenon to be analysed due to the lack of proper instruments to aid our observation or due to the want of a sufficient number of instances or due to carelessness.

There are two forms of non-observation; non-observation of instances and non-observation of essential circumstances. The former consists of overlooking relevant instances or facts of the phenomenon in question. The main cause of this error is bias. Scientists must have a sincere desire for truth. But many commit the fallacy of attending only those facts that support their prejudices or preconceived theories and neglect those that go against them. Non-observation of essential circumstances is due to the neglect of necessary circumstances connected with the phenomenon under investigation. In most social, political, or economic phenomena, we are likely to ignore some important and vital circumstances that would make all the difference in our conclusion.

- Non-observation has two forms: missing relevant facts due to bias and neglecting essential circumstances

4.1.2.3 Fallacies of Mal-observation

It is due to the wrong interpretation of the observed fact. In this fallacy, what is perceived is misunderstood. It is a wrong or mistaken observation. This is a positive fallacy of commission. While in non-observation we omit to observe certain things, in mal-observation we see something, but it is wrongly seen. Very often we confuse facts with fancies arising from likes and dislikes, fear, or other subjective feelings. We mix up facts with inferences based on those facts. Thus, mal-observation is a wrong observation, distortion, or misrepresentation of what is observed. When we mistake a piece of rope for a snake, it is due to mal-observation.

- Mal-observation is the wrong interpretation or misunderstanding of observed facts

4.1.3 Types of Induction

Inductive inferences occur in a large variety of forms. Out of them, four types of inductive inferences are recognized in Elementary logic. They are

- Enumerative Induction
- Induction by Analogy
- Induction by Statistics
- Scientific Induction

4.1.3.1 Enumerative Induction

- simple enumeration is the formulation of a universal proposition based on the number of observed instances

Enumerative induction is a method of making a universal proposition on the basis of a mere number of observed instances. It is a process of simply counting the instances of the phenomenon under investigation. It does not analyse the instances to find out their nature rather merely counts the instances. It is of two kinds. They are:

- Perfect induction or complete enumeration
- Simple enumeration or imperfect induction

4.1.3.2 Perfect Induction

- Perfect induction derives a universally certain proposition by counting all instances of a phenomenon

Perfect induction is a method of arriving at a universal proposition after counting all the instances. It is a generalisation based on an exhaustive enumeration of all the instances of a given phenomenon. For example, after counting the number of days in each month, we say that 'all months of the year have less than 32 days each'. In Perfect induction, counting is complete and the universal proposition arrived at by this method is absolutely certain. That is why it is called perfect.

- Complete enumeration offers a total summary of the observed facts

Perfect induction, as termed by Aristotle, is possible only in those cases where the total number of instances can be counted or observed. The proposition reached by this method is universal only in appearance. It is arrived at by adding all the instances together. The conclusion does not give any new information. And there is no inductive leap in perfect induction. It is unscientific because it merely counts. It does not analyse a given phenomenon and explain the causal connections. It merely states a 'that' and not a 'why'. And it can be applied only if the instances are few and limited. For example, we cannot count all the men in the world to make a general law that 'All men are mortal'. The conclusion of induction by complete enumeration or perfect induction is like a total 'summary of facts'.

- Simple enumeration involves observing a limited number of instances

Simple enumeration is the simplest and most popular form of induction. In simple enumeration, unlike perfect induction, we do not count all the instances. It is not always possible, especially if the instances cover a wide field. So, what we do is, to count a few of them and then make a general statement covering not only the observed ones but also the unobserved ones. For example, we count several crows; we notice their colour and then make the general statement that 'All crows are black'.

4.1.3.3 Merits of Simple Enumeration

- Simple enumeration aids in forming hypotheses

This method has an inductive leap. It is also based on the law of uniformity of nature. It is very useful in all phenomena where the number of instances is large and where perfect counting is impossible. All social phenomena cannot be counted completely. Thus, where scientific analysis is impossible, we have to depend on simple enumeration. Since the method is based only on counting and not on analysis of instances, even ordinary people can use this method. It is of very great advantage to scientists, as it covers a wide field of instances. So simple enumeration is the first stage of scientific induction. Another advantage is that it suggests at least a probability, though not an absolute certainty. This probability increases with the increase in the number of instances. If we examine a large number of instances, and if we do not come across a single contradictory experience, we can even say that the conclusion made will be certain. Another thing is that, it helps to form a hypothesis. In helping the formation of a hypothesis, it helps scientific induction.

- Simple enumeration is unscientific

In spite of these, it has some defects also. It is unscientific because it does not discover the causal connection by analysing the facts. It is based only on counting. As already stated, counting can give only a 'that' and not 'why'. The conclusions are merely empirical laws and not scientific universals expressing causal connection. A fact even if we see it a hundred times cannot be generalised. Another defect is it gives only a probability and never a certainty. This method leads to the fallacy of hasty generalisation. That is, on observing a few instances, we hasten to generalise, neglecting the unfavourable instances.

4.1.4 Analogy

- Analogy infers greater resemblance based on partial similarities

It is a method of inductive reasoning in which a more complete resemblance between things is inferred from their partial resemblances in certain points. For example, the planets, Mars and the Earth resemble each other in several ways. Both have day and night; both have land and sea and atmosphere; both go around the sun and borrow light from the sun; both revolve on their own axis; both are subject to the law of gravitation. Now, the earth is inhabited by human beings and other animals. So, Mars too must be inhabited. In analogy, the ground or principle of inference is similarity.

4.1.4.1 Rules of good analogy

Any argument based on resemblances is not a sound or valid analogy. A good argument from analogy must fulfil certain requirements. The strength of an analogical argument depends on the following conditions.

The points of resemblance must be essential and relevant to the conclusion drawn.

The common qualities must be basically connected with the inference drawn from them. Mere superficial external and accidental resemblances cannot be the basis of the conclusion. For example, two students X and Y, resemble each other in their height, diet, weight, class, age, residence, etc. Now X gets a first class in the B. A. Degree examination. Therefore, Y also would get a first class. In this analogical argument, the inference is based on accidental and irrelevant similarities between X and Y. Their resemblances, though numerous, have no necessary connection with the question of first class. Hence, it is a bad or unsound analogy. It is wrong to think that the value or the strength of an analogical inference depends on the number of resemblances.

There should be no essential or fundamental differences between the things compared.

While the resemblances are essential and necessary, the difference between the things compared must not be significant and vital. The less the number and importance of the points of difference, the greater the value of an analogy. If any essential and striking points of difference were to be overlooked, the analogy would be an unsound one. For example, whales and sharks resemble each other in their shape, food, in living underwater, in having backbones, etc. Therefore whales too, like sharks, breathe oxygen from water. This is an unsound analogy.

The analogy must be based on fairly extensive knowledge of the things compared.

If our knowledge is not exhaustive, we cannot know all the essential points of resemblances and the vital differences between them. We would consequently commit the fallacy of bad or false analogy. In short, a sound analogy is an argument in which the conclusion is based on the presence of essential resemblances, the absence of vital differences, and a fairly

wide knowledge of the things compared. An unsound or false analogy is one in which the resemblances are very small and external differences are very great and vital.

4.1.4.2 Value or Use of Analogy

- Analogy is a fertile source of hypothesis

The analogy is a fertile source of hypothesis. Similarities between phenomena suggest probable laws of connection. Suggesting possible explanations or hypothesis analogy has led to a great number of scientific discoveries. Where direct proof is not possible, argument from analogy is of great value. The analogy makes difficult and abstract ideas clear, concrete, vivid, and picturesque. For example, the law of the unity of nature is made clear by the analogy of the unity of the human body in spite of its numerous organs. Another thing is that, analogy is superior to enumerative induction. While enumerative induction merely counts instances of a phenomenon, analogy analyses the similarities between two phenomena.

4.1.4.3 Limitations of Analogy

- Analogy is an incomplete process of induction

Analogy argues from one particular to another on the basis of some similarity between the two cases. The universal principle behind analogical reasoning is not completely analysed or defined. It is an incomplete process of induction. It observes resemblances between facts and suggests a hypothesis but never takes the trouble of verifying and proving it. When an analogy is interpreted too literally, it can lead to misleading conclusions. Figures of speech like similies and metaphors are used as analogies. But they are not good arguments that prove a point; they are only good examples to make an idea clear and impressive.

4.1.5 Scientific Induction

- Scientific induction infers general principles from specific observations

Scientific induction refers to the process by which general principles or theories are inferred from specific observations or instances. It is a fundamental aspect of the scientific method and plays a crucial role in developing our understanding of the natural world. Inductive reasoning involves making conclusions based on patterns observed in empirical data, with the understanding that these conclusions might not be absolute truths but rather well-supported generalisations.

The purpose of scientific induction is to establish general laws. This law is true for all time and space. For example, 'All material bodies have gravitational force'. This general law must be true. The goal of scientific induction is not to make a collective universal, but a scientific or generic universal. Sci-

- Scientific induction establishes general laws

entific induction is based on facts. It is the result of observing concrete and particular facts occurring around us. It selects a few instances and then analyses them or breaks down in order to understand their governing principles. Scientific induction is based on two fundamental principles, namely the law of causation and the law of uniformity of nature.

Summarized Overview

Induction is a way of learning and understanding the world by making educated guesses based on observations and experiments. It helps us create general rules or principles from particular examples. There are several kinds of induction, such as enumerative induction, induction by analogy, induction by statistics, and scientific induction. Enumerative induction involves generalizing from a count of observed instances, while induction by analogy draws conclusions from resemblances between things. Induction by statistics relies on statistical data, and scientific induction aims to establish general laws through empirical observation. While these forms of induction differ in their approaches, they all rely on the fundamental principles of the law of causation (everything happens for a reason) and the law of uniformity of nature (things keep happening the same way over time) to make informed inferences about the world. These principles make inductive reasoning more reliable, but it is important that inductive conclusions are based on probability, and not on absolute certainty.

Self-Assessment

1. Provide a brief explanation of induction as well as the Problem of Induction.
2. Briefly discuss the different types of induction and explain their distinctions.
3. Make a brief overview of the concept of analogy with examples.

Assignments

1. Differentiate between deduction and induction, and explain which one is more reliable. Provide reasons for your answer.
2. Take note of the Problem of Induction and elucidate how the postulates of induction aid in overcoming this challenge.
3. Explore the problems associated with observation.

Reference

- Wolf, A. (2018). *Textbook of Logic* (2nd ed.). Routledge, Taylor & Francis Group.
- Copi, I. M., & Cohen, C. (2017). I*ntroduction to Logic* (15th ed.). Routledge.
- Hurley, P. J. (2016). *A Concise Introduction to Logic*. Cengage Learning.
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UNIT 2
Scientific Method

Learning Outcomes

After the completion of this unit, the learner will be able to:

- grasp the fundamental steps of the scientific method.
- recognize the significance of empirical evidence in scientific induction.
- gain the ability to formulate testable hypotheses based on patterns they observe in data.
- develop proficiency in analysing experimental data, identifying trends, and drawing conclusions.
- differentiate between correlation and causation.

Background

The scientific method in induction is the cornerstone of empirical inquiry and knowledge generation. By understanding the scientific method, one can employ a structured and systematic approach to making informed inferences about the world. The scientific method provides a framework that promotes the reliability and credibility of the conclusions drawn from empirical investigations. In essence, the study of the scientific method in induction is essential for fostering a deeper understanding of the natural world, advancing our collective understanding of its workings, and driving progress in the field of knowledge.

Keywords

Observation, Scientific Induction, Crucial Experiments, Ad Hoc Hypothesis

Discussion

4.2.1 Stages of Scientific Induction

There are four stages in the process of scientific induction.

They are;

- Observation of facts
- Formulation of hypothesis
- Verification of hypothesis
- Proof

Observation of Facts

- Observation involves analysis and elimination of facts

Observation of facts is the first step in the inductive procedure. Relevant facts are collected from various sources and then they are analysed in order to find out their nature. After analysing or breaking down the complex phenomenon into its various factors, all unnecessary and accidental facts are eliminated. Thus, observation involves analysis and elimination; where observation is impossible, we must take the help of experiment. Analysis and elimination require what is called 'varying the circumstances'. The observation involves five factors; collection, definition, analysis, elimination, and varying circumstances. For example, to study the cause of cancer, we begin with the collection of actual cases of cancer.

Formulation of Hypothesis

- Hypothesis is the guess about the cause

When the instances are observed, a guess will naturally arise in our mind as to their causal connection. This guess is technically called a hypothesis. A hypothesis is a guess about the causes of an event. When Newton saw the apple falling to the ground, he guessed that it may be due to the attraction of the earth.

Verification of Hypothesis

- Verification is testing the hypothesis as to whether it is true or false

Verification of Hypothesis is the third stage of the inductive procedure. It means testing the hypothesis whether it is true or false. Verification may be direct or indirect. In direct verification, we compare the hypothesis with actual facts. If the facts agree with the hypothesis, it is said to be true. For example, if you see a crowd at a distance, you make a hypothesis as to its cause that there might have been an accident. Now, to verify this, you directly go to the spot, and see whether the crowd is due to an accident or not. In indirect verification, we must first assume that the hypothesis is true. Then, we deduce all the consequences that should follow from it, if it is true.

Now, compare the deduced consequences with actual facts. If the deduced consequences agree with actual facts, the hypothesis is said to be true.

- Verification is an incomplete explanation

A verified hypothesis is called only a theory and not a law. Verification merely shows that the hypothesis explains the fact. It does not show that it is the only explanation. Since verification is only an incomplete explanation, we need another stage to make it a law.

Proof of Hypothesis

- A verified theory is called a law

Proof of hypothesis is the final stage. It consists in showing that this is the hypothesis that can explain the fact and that there are no rival hypotheses. This is extremely difficult and is rarely accomplished in science. Sometimes, several hypotheses or theories seem to explain the same fact, but we know that there can be only one cause for the same effect. Hence, we must disprove the rival theories and determine the right theory. This is done by a crucial instance. In induction, a crucial instance helps us to detect the correct hypothesis and at the same time reject the false ones. Thus, scientific induction makes use of crucial instances to prove a hypothesis and to decide between the rival hypothesis. Observation of facts gives rise to a hypothesis. Hypothesis when verified becomes a theory. When the theory is proved, it is called a law. This is the procedure of scientific induction.

4.2.2 Hypothesis

- Hypothesis is a tentative or probable explanation

The human mind is ever eager to know the 'why' of things. It is the tendency of the mind to leave nothing standing in isolation but to explain the various parts of experience by bringing them into relation with one another. The guess put forward to explain an event is known as a hypothesis. The hypothesis is an attempt to explain the cause of a new fact and form a tentative or probable explanation of the causality of an observed fact. Suppose we find the ground wet one morning, we are tempted to assume that it must have rained the previous night.

There is a difference between the term 'hypotheses' and the term 'theory'. Theory is often used as an equivalent to a hypothesis, but it is better to use the term 'hypothesis' for the unverified phenomenon and use the term 'theory' for that hypothesis which has been completely proved and found to be true. Hypotheses are made use of not only in science but also in practical life. Even illiterates suggest several hy-

potheses about the ordinary facts which they come across in their experience. When a man falls ill, others suggest that the illness is due to improper diet or overwork. It is called a popular hypothesis. A popular hypothesis tries to explain one fact by means of another fact. It is factual and superficial. On the other hand, a scientific hypothesis is a guess made to explain a phenomenon in terms of an inner law that governs it. Newton's law of Gravitation and Darwin's Law of Natural selection are good examples of scientific hypotheses. Thus, the difference between popular and scientific hypotheses is one of degree and not of kind. Both are attempts at explaining facts. One is more precise and comprehensive than the other.

- Scientific hypothesis is guesswork in order to explain the phenomena

4.2.2.1 Sources of Hypothesis

The various types of induction such as simple enumeration, statistics, and Mill's five methods help us much in the formation of a hypothesis. Simple enumeration observes a few facts and generalises on the basis of uncontradicted experience. It does not establish a law but merely suggests one. The chief value of the enumerative method lies in its power to suggest a causal relation. Even a perfect induction which counts all the instances of a phenomenon suggests a good hypothesis.

- Enumerative method suggests a causal relation

Analogical induction is the most fertile source of hypothesis. The analogy is based on partial resemblances between two things. It cannot prove a law. It merely suggests a possible causal relation between facts. The next source is statistical induction. When facts and figures relating to a phenomenon are collected and classified systematically, the corresponding variations between two sets of figures suggest a possible causal connection between facts. Mill's method, especially the observational methods are a fruitful source of hypothesis. The conclusion reached by the method of agreement and the joint method is only probable. They cannot prove a causal connection but only suggest one.

- Analogical induction is based on partial resemblances

4.2.2.2 Importance and Uses of Hypothesis

The hypothesis is necessary for the acquisition and development of knowledge. Without the hypothesis, we may not know what to observe and what experiments to conduct. Observation and experiment become purposive and selective only in a case where a hypothesis is present. The importance of hypothesis in scientific induction can hardly be exaggerated. All sciences start with a hypothesis. The discovery of a law in a science is the result that proceeds by way of a hypothesis. A law is the result of framing, testing, and proving a hypothesis.

- Hypothesis is very much necessary for scientific induction

Thus, hypothesis occupies a central place in scientific induction.

The first stage of scientific induction is the observation of facts. But no observation is possible without a hypothesis. What we select to observe depends on the motive or purpose we have in our mind. We do not approach facts with an empty mind.

4.2.2.3 Verification and Proof of Hypothesis

Even a legitimate hypothesis is still a supposition. It has to be tested to see whether it is a correct explanation of the phenomenon in question. In the process of establishing the truth of a hypothesis, there are two main steps namely, verification and proof.

Verification of a hypothesis means the process of testing the truth of a logical hypothesis by comparing it with facts. It may be direct or indirect. Direct verification consists of comparing the hypothesis itself with facts. It may be done by observation or by experiment. For example, it was supposed that the deviation of the planet Uranus from its calculated orbit was due to the attraction of a new planet close by. This was directly verified by observation through a telescope and, as a result, the planet Neptune was discovered. Indirect verification consists of two stages. First, the hypothesis is assumed to be true and certain consequences are deduced from it. The deduced consequences are then compared with actual facts. If the inferred consequences agree with the facts, then the hypothesis is verified. If on the other hand, the inferred consequences do not agree with the facts, then the hypothesis is rejected or modified. It is indirect because the truth of the supposed cause is tested by comparing the deduced consequences with facts and not by comparing the hypothesis itself with facts.

- Verification may be either direct or indirect

Since verification is an incomplete process, something more than mere verification is necessary for establishing a hypothesis. This is called the proof of a hypothesis. The proof of a hypothesis consists in showing that the verified hypothesis is the only adequate explanation of the given phenomenon and that there are no other rival hypotheses to adequately explain the same phenomenon. The verified hypothesis must be shown to possess exclusive sufficiency to explain the given phenomenon. When several theories seem to be possible for one and the same phenomenon, only one of them must be correct. According to the postulate of induction, the same cause produces the same effect under the same conditions. To decide between the

- Verified hypotheses are the sole satisfactory explanation for the observed phenomenon

rival theories, we make use of what is known as the 'crucial instance'. A 'crucial instance' is a fact that can be explained only by one of the several rival hypotheses. It enables us to find out the correct hypothesis and at the same time reject the others as false. It is the deciding factor between two or more rival hypotheses.

4.2.2.4 Crucial Experiments and Ad Hoc Hypotheses

Crucial experiments and ad- hoc hypothesis are concepts often discussed in the context of scientific research and the philosophy of science.

Crucial Experiments

- A crucial experiment provides decisive evidence in favour of a particular hypothesis

A crucial experiment is an experiment designed to provide decisive evidence in favour of a particular hypothesis or theory. It is intended to definitively test the validity of a hypothesis by producing results that strongly support one explanation over others. A crucial experiment is carefully designed to eliminate ambiguity and potential sources of error, making the outcome clear and unambiguous. Successful crucial experiments can have a profound impact on the direction of scientific research, as they can either confirm or disprove a hypothesis, leading to a better understanding of the underlying phenomena.

Ad Hoc Hypothesis

- Ad hoc hypothesis explains a specific observation or set of data that contradicts an existing theory or hypothesis.

Ad- hoc hypothesis is a hypothesis introduced to explain a specific observation or set of data that contradicts an existing theory or hypothesis. It is often created on the spot to 'save' the existing theory from being refuted by new evidence. Ad hoc hypotheses can be problematic because they are typically not well-motivated by independent evidence and can make a theory less elegant and parsimonious. In essence, they are introduced solely to address a particular anomaly without necessarily having broader explanatory power.

- Ad hoc hypothesis hinders the progress of science

In the context of the scientific method, ad hoc hypotheses are generally seen as less desirable because they can hinder the progress of science by preventing the refinement or rejection of inadequate theories. Science aims for theories that are both robust and able to explain a wide range of observations. When scientists encounter unexpected results, they often seek to understand whether these results indicate the need for a new theory or an adjustment to the existing one, rather than resorting to ad hoc explanations.

- Ad hoc hypothesis explains specific observations that challenge existing theories.

Crucial experiments are designed to provide strong evidence for or against a hypothesis, while ad hoc hypotheses are introduced to explain specific observations that challenge existing theories. The scientific community generally values theories that are well-supported by evidence and can explain a variety of phenomena without relying on ad hoc explanations.

4.2.2.5 Different Kinds of Hypothesis

- **Working Hypothesis**

- A working hypothesis is temporary and should change or be discarded if it conflicts with the facts.

Hypothesis, as we have seen, is intended for the explanation of observed facts. Its main function is to systematise the known facts and also serves for future enquiry. A hypothesis may perform these tasks, but it does not become true. If facts are found to be inconsistent with this, the hypothesis should either be rejected or modified. Such a hypothesis is called a working hypothesis. A working hypothesis therefore means a provisional supposition that, though known to be inadequate, is still accepted for the time being because, in the absence of a better hypothesis, it is used as a guide. A working hypothesis, though likely to be rejected, has some value because it forms the basis for future explanation.

- **Barren Hypothesis**

- Barren hypothesis offers no practical insight due to our limited understanding of such phenomena

A hypothesis that leads nowhere is called a barren hypothesis. We simply do not know what to do with it. It may be either true or false. Some years ago, in the Bellary district, in a house, vessels were violently broken, clothes torn and hideous laughter was heard. Nobody was able to identify the cause for this. The people of that locality explained this occurrence by thinking that it was caused by a spirit haunting that house. This is a fine example of a barren hypothesis because we really know nothing about the behaviour of such supernatural beings.

- **False Hypothesis**

- A false hypothesis is one that has been proven incorrect.

A false hypothesis is a supposition which is proved and found to be false. False hypothesis has a place and a certain function in thinking. Sometimes, a false hypothesis leads to a true one.

- **Rival Hypothesis**

- An equally important hypothesis is known as a rival hypothesis.

The hypothesis that appears to be equally important is called the rival hypothesis. In order to establish the validity of any particular hypothesis, we have to disprove all rival hypotheses by means of a crucial instance.

4.2.3 Seven Stages of Scientific Investigation

The scientific investigation process can be roughly divided into several stages, although the specific steps and their order can vary depending on the nature of the research and the field of study. Here is a general outline of the seven stages of scientific investigation:

- *Observation:* This stage involves observing and gathering information about a phenomenon or problem in the natural world. Observations can be made through experiments, measurements, surveys, or simply by noting patterns in existing data.
- *Question Formulation*: Based on the observations, researchers formulate specific questions or problems that they want to address. These questions should be clear, focused, and capable of being investigated through empirical methods.
- *Hypothesis Development:* A hypothesis is a testable explanation or prediction for the observed phenomenon. It is a tentative answer to the research question. A good hypothesis is specific, measurable, and provides a clear cause-and-effect relationship to be tested.
- *Prediction:* From the hypothesis, researchers generate predictions that can be tested through experiments or observations. These predictions describe expected outcomes under specific conditions if the hypothesis is correct.
- *Experimentation or Data Collection:* Researchers design and conduct experiments or gather data to test the predictions derived from the hypothesis. This stage involves setting up controlled conditions, collecting data, and ensur-

ing that the methods are rigorous and repeatable.

- *Analysis:* The collected data is then analysed using statistical or other relevant methods to determine whether the predictions match the observed outcomes. This analysis helps researchers draw conclusions about the validity of their hypothesis.
- *Conclusion and Communication:* Based on the analysis, researchers draw conclusions about whether the hypothesis is supported or not. These conclusions are communicated to the scientific community and the public through research papers, presentations, and other forms of dissemination. Transparency is crucial here, including sharing methods, data, and any limitations encountered during the investigation

Summarized Overview

Induction plays an important role in the realm of scientific methodology, offering a systematic approach to uncovering the mysteries of the natural world. Scientific method, a well-structured process, starts with the foundational step of observation, then crafting insightful hypotheses (educated guesses) based on what we observe. These hypotheses serve as guiding lights, directing the scientific inquiry towards a comprehensive understanding of complex phenomena. The verification stage follows, where these hypotheses are subjected to careful testing, either through direct comparisons with observed facts or by deducing and scrutinising their consequences. Finally, the last stage marks the proof of hypotheses, the apex of scientific induction. In this stage, verified hypotheses, proven to be the most satisfactory explanations for specific phenomena, ascend to the status of scientific laws, supported by crucial instances. These stages, connected by inductive reasoning, work like a path that takes us from just looking at things to really understanding how the world operates. This method, based on inductive thinking, lets us ask questions, come up with good guesses, do careful tests, and only accept the best explanations as scientific laws. This helps us explore and learn more about the complex workings of the world.

Self-Assessment

1. What are the stages of scientific induction? Provide a detailed explanation.
2. Discuss various types of hypotheses in detail.

Assignments

1. Elaborate on the significance of hypotheses in the scientific method.
2. Enumerate the various types of hypotheses and discuss their significance.
3. Provide a brief discussion on why induction is widely utilized in the scientific method.

Reference

- Wolf, A. (2018). *Textbook of Logic* (2nd ed.). Routledge, Taylor & Francis Group.
- Copi, I. M., & Cohen, C. (2017). *Introduction to Logic* (15th ed.). Routledge.
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UNIT 3
Causal Connections

Learning Outcomes

After the completion of this unit, the learner will be able to:

- understand the concept of causality
- develop skills in identifying causal relationships within various scenarios
- critically assess proposed causal connections, considering factors such as temporal sequence, correlation strength, and plausible mechanisms of causation.
- become more adept at recognizing and avoiding common fallacies
- understand the difference between necessary causes and sufficient causes
- understand the significance of John Stuart Mill's experimental method

Background

Cause-effect relations play an important role in induction, a method of reasoning where we make informed inferences based on observed events and evidence. By studying these relationships, we can discern patterns and regularities in the natural world, enabling us to formulate hypotheses about why certain events occur, which is a fundamental step in the inductive process. Inductive reasoning allows us to systematically test these hypotheses, confirming or refining our understanding of cause-effect relations. John Stuart Mill, a 19th-century philosopher and economist, significantly contributed to the development of inductive logic concerning cause and effect. This exploration empowers us to unravel mysteries, make predictions, and drive progress in various fields, serving as a foundation of logical thinking, scientific inquiry, and problem-solving.

Keywords

Cause, Effect, Method of Agreement, Method of Difference, Joint Method of Agreement and Difference, Method of Concomitant Variation, Method of Residue.

Discussion

4.3.1 Cause and Effect

- Cause is the antecedent, effect is the consequent

Determination of the cause is the most essential problem of induction. By finding out the causal connection, we can understand the systematic character of the universe. The word 'cause' has been used in different senses. The undeveloped minds of savages have their own conception of cause. They think that events are due to the actions of some supernatural beings. It consists in attributing natural events to supernatural beings. Some people think that an event is endowed with life. That event occurs because it has life in itself. This view is known as animism. The most popular idea of the cause consists of considering any preceding or earlier event as the cause of the succeeding or later event. That is, the cause is the antecedent and the effect is the consequent. For example: His father died and he lost all his money. This causal connection is just considered as a relation of 'before' and 'after'. From among the many antecedent circumstances, one is considered as the cause.

- Mere occasions and symptoms are not themselves causes

Even negative circumstances are considered as the cause of the phenomenon. For example, the absence of wealth is the cause of suicide. Occasionally a mere occasion is mistaken for a cause. Occasion means an opportunity suitable for doing something. For example, darkness is an occasion that may help the event to occur, but it is not the cause. There are also people who mistake a symptom for cause. Symptom means a sign of the existence of something, but it is not the cause. For example, high temperature is a symptom of fever.

4.3.1.1 Scientific Definition of Cause

- Causes is the invariable and unconditional or necessary antecedent

From the point of view of modern science, Mill defines, causes as 'the invariable and unconditional or necessary antecedent'. That is, cause is the totality of conditions of which the effect invariably and unconditionally follows. According to Mill, the characteristics of a scientific cause are the following;

Cause is an antecedent:

Cause is an antecedent means that the cause of an event is prior to the event. Cause precedes the effect and produces the effect. When we say that the cause is an antecedent, it is likely to think that there is a time interval between cause and effect. This mistaken view is due to some effects, such as taking the poison and the consequences after some hours. But if we examine it closely, we can find that there is no time interval at all. We neglect to notice the intermediate changes between cause and effect. Cause implies only a relative priority and not a relation of before and after in time. Heat expands metals. Here, 'heat' and 'expansion' are simultaneous, and yet heat is relatively prior to the expansion. Thus, the relation of cause and effect is not one of sequence. Rather in reality, the cause transforms into the effect. The cause implies the effect. In the case of a table, wood serves as the cause, giving rise to the effect, table.

- Cause transforms into the effect

All antecedents cannot be considered as a cause. Sunlight may be an antecedent to the burning of a house, but it is not the cause because the house would burn equally well at night. Before we come to the class, we have our coffee. But this antecedent, namely taking coffee is not the cause of attending the class.

Cause is an invariable antecedent:

Hume defines cause as the invariable antecedent. Something more than mere antecedent is necessary for an event to be called a cause. It must possess invariability too. There are innumerable antecedents that happen before an event. Most of them will not have any connection with the event at all. The cause must be looked for among those antecedents which are invariable. That means the antecedent must always be present with the effect and it must always be followed by the effect. Both must go together. Whenever the cause is present, the effect also must be present and whenever the cause is absent the effect also must be absent. The cause is the totality of positive and negative conditions which are invariable and necessary antecedents of a phenomenon.

- Cause is the invariable antecedent

Cause is an invariable and unconditional antecedent of an effect:

An invariable antecedent cannot be called a cause if it is not unconditional. Here, Mill corrects Hume's definition by adding the quality of unconditionality to the invariable antecedent. Antecedent must be unconditional. Unconditionality

- Cause is unconditional

means that the antecedent must be followed immediately by the effect without waiting for any other condition. As soon as the antecedent is present, the effect must take place whether other circumstances are present or not.

Cause is an immediate antecedent:

Unconditionality implies immediateness. Whether other circumstances are present or not, as soon as the cause is present, the effect must immediately follow from the cause. Nothing should intervene between cause and effect.

Reciprocity or reversibility:

Reciprocity or reversibility is another characteristic of causation. As the same cause produces the same effect, we must be able to infer the effect from the given cause and the cause from the effect.

Cause is the totality of conditions:

- Effects results from a combination of necessary conditions

The cause of an event is not always a single antecedent but a group of antecedents, all of which are necessary for the phenomena to occur. Each of the antecedents has some influence on the effect and hence it is known as a condition. Several conditions combine together to produce an effect. In the absence of any of these conditions, the effect should not take place.

Qualitatively, cause is equal to the effect:

To these qualitative marks of cause, namely, antecedent invariability, necessity, immediateness, reciprocity, and totality of conditions, a new element is added to the idea of cause in its application to physical phenomena. According to the law of conservation of matter and energy, the total quantity of matter and energy in this world remains constant. Thus, the matter and energy of the cause are equal to the matter and energy of the effect. This is true only of physical phenomena, where measurement is possible and cannot apply to mental phenomena.

4.3.2. Mill's Experimental Methods

Mill's methods are intended to find out the true cause of events. This is done by a process of analysis and elimination. The phenomenon to be investigated is very often complex. Hence, the first step in the determination of the cause of an event by analysing it into separate factors and studying

all the antecedent circumstances in detail. By applying certain rules of elimination, we exclude all the accidental and irrelevant circumstances. The principles of elimination are four. They are:

- That particular instance is not the cause of the phenomenon in the absence of which the phenomenon occurs
- That particular instance is not the cause of the phenomenon in the presence of which the phenomenon fails to occur
- That particular instance is not the cause of the phenomenon which varies when it is constant
- That particular instance is not the cause of a phenomenon that is known to be the cause of a different phenomenon.

All the principles are obtained from the very definition of scientific cause. Mill's methods are divided into five. They are: The method of agreement, The method of difference, The joint method of agreement and difference, The method of concomitant variation, The method of residues.The method of agreement

4.3.2.1 Method of Agreement

If two or more instances of the phenomenon under investigation have only one circumstance in common, the circumstance in which all the instances agree is the cause (or effect) of the given phenomenon. For a property to be a necessary condition, it must always be present if the effect is present. Given this, we are interested in looking at cases where the effect is present and taking note of which properties, among those considered to be 'possible necessary conditions' are present and which are absent. Obviously, any properties that are absent when the effect is present cannot be necessary conditions for the effect. Symbolically, the method of agreement can be represented as:

- The common circumstance in which all the instances agree is the cause

A B C D occur together with w x y z

A E F G occurs together with w t u v

Therefore, A is the cause, or the effect, of w.

Examples

1. Suppose we want to investigate the expansion of metals. We heat a bar of iron and find that it expands. We then heat bars of silver, copper, zinc, gold, etc. We find that each bar

expands. We conclude that heat is the cause of the expansion of metals.

2. Suppose we want to know the cause of malaria. We study a number of malarial patients, who differ in sex, age, food strength, and heredity. All of them sleep without mosquito nets. We conclude that mosquitoes are the cause of malaria.

4.3.2.2 Method of Difference

- Differing factor in similar situations is the cause or effect.

If an instance in which the phenomenon under investigation occurs, and an instance in which it does not occur, have every circumstance save one in common, that one occurring only in the former; the circumstance in which alone the two instances differ, is the effect, or cause, or an indispensable part of the cause, of the phenomenon. That means, if everything is the same in two situations except one factor present only when the phenomenon occurs, that differing factor is seen as a potential cause or a necessary part of the cause of the phenomenon.

This method is also known more generally as the most similar systems design within comparative politics.

A B C D occur together with w x y z

B C D occur together with x y z

Therefore, A is the cause, or the effect, or a part of the cause of w.

As an example of the method of difference, consider two similar countries. Country A had a centre-right government, and a unitary system, and was a former colony. Country B has a centre-right government, a unitary system but was never a colony. The difference between the countries is that Country A readily supports anti-colonial initiatives, whereas Country B does not. The method of difference would identify the independent variable to be the status of each country as a former colony or not, with the dependent variable being supportive of anti-colonial initiatives. This is because, out of the two similar countries compared, the difference between the two is whether or not they were formerly a colony. This then explains the difference in the values of the dependent variable, with the former colony being more likely to support decolonisation than the country with no history of being a colony.

4.3.2.3 Indirect Method of Difference

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

- Common circumstance where the phenomenon occurs and differing from cases where it does not, is the cause of it.

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. It is also called the "Joint Method of Agreement and Difference", this principle is a combination of two methods of agreement. Despite the name, it is weaker than the direct method of difference and does not include it.

Symbolically, the joint method of agreement and difference can be represented as:

A B C occur together with x y z

A D E occur together with x v w

F G occurs with y w

Therefore, A is the cause, or the effect, or a part of the cause of x.

For example,

A person passes a sleepless night whenever he works very hard. Whenever he avoids very hard work, he gets a sound sleep at night. He concludes that very hard work is the cause of his sleepless nights.

4.3.2.4. Method of Residue

Subduct from any 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. If we know the effects of all the possible causes except one, and we observe an effect that is not caused by any of the known causes, then that effect must be caused by the unknown cause. In other words, if we can eliminate all other possible explanations for something, then the remaining explanation must be the correct one.

Symbolically, the Method of Residue can be represented as:

A B C occur together with x y z

B is known to be the cause of y

C is known to be the cause of z

Therefore, A is the cause or effect of x.

For example,

We weigh a wagon with coal. We know the weight of a wagon without coal. We subtract it from the weight of the

wagon filled with coal and we get the weight of the coal.

4.3.2.5 Method of Concomitant Variations

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 fact of causation.

If across a range of circumstances leading to a phenomenon, some property of the phenomenon varies in tandem 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 tandem with the level of lead, one could attribute the toxicity to the presence of lead.

Symbolically, the method of concomitant variation can be represented as (with ± representing a shift):

A B C occur together with x y z

A± B C results in x± y z.

Therefore, A and x are causally connected

Unlike the preceding four inductive methods, the method of concomitant variation doesn't involve the elimination of any circumstance. Changing the magnitude of one factor results in a change in the magnitude of the other factor.

Summarized Overview

Cause and effect are vital for comprehending how events are interconnected. Causes are the conditions or factors responsible for bringing about particular effects, and they must meet specific criteria to qualify as true causes, including invariability, necessity, immediateness, reciprocity, and totality of conditions. The scientific definition of cause, emphasises its role as an invariable and unconditional antecedent. The methods like the method of agreement, difference, concomitant variations, and residue help in identifying and understanding causal relationships in different scenarios. These methods enable us to identify the factors consistently associated with specific effects, enhancing our grasp of the connections between events and their underlying conditions.

Self-Assessment

1. Explain the 'method of agreement' as a tool for identifying causes and give illustrative examples.
2. Discuss the 'method of difference' and its practical application.
3. Describe the joint method of agreement and difference and highlight its distinctions from the direct method of difference.

Assignments

1. Define the characteristics of a scientific cause, emphasising the significance of invariability and immediateness.
2. Provide a concise overview of Mill's methods.

Reference

- Stebbing, S. (2014). *A Modern Introduction to Logic.* Dover Publications.
- Creighton, J. E., & Smart, J. J. C. (1978). *Introduction to Logic*. Methuen & Co.
- Mahadevan, T. M. P. (2008). *Introduction to Logic*. Tata McGraw-Hill Education.
- Cohen, I. M., Cohen, C., Prabhakar, M., & Prabakar, P. (2009). *Introduction to Logic* (13th ed.). Pearson.
- Stanbatonett, J., & Sen, M. (2009). *Logic* (1st ed.). Pearson Prentice Hall.
- Cohen, M. R., & Nagel, E. (1934). *Introduction to Logic and Scientific Method.* Harcourt, Brace and Company.

Suggested Reading

- Chakraborti, C. (2013). *Logic: Informal, Symbolic & Inductive*. New Age International.
- Jain, K. (2008). *A Textbook of Logic.* D K Print World (P) Ltd.
- Hurley, P. J. (2014). *A concise Introduction to Logic* (12th ed.). Cengage Learning.
- Creighton, J. E., & Smart, J. J. C. (1973). *An Introduction to Logic* (2nd ed.). Routledge.

Space for Learner Engagement for Objective Questions

Learners are encouraged to develop objective questions based on the content in the paragraph as a sign of their comprehension of the content. The Learners may reflect on the recap bullets and relate their understanding with the narrative in order to frame objective questions from the given text. The University expects that 1 - 2 questions are developed for each paragraph. The space given below can be used for listing the questions.

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