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Q: What is Symbolic logic?
How does it differ from
Aristotlian logic?

Ans: Introduction

Logic is the study of valid reasoning and correct inference.

Two milestones dominate its history:

Aristotlian logic, developed in the 4th century BC as the first systematic study of deduction, and Symbolic logic, developed in the 19th-20th centuries, which revolutionized reasoning by introducing symbols, truth-values, and quantifiers. Both aim at the same goal, distinguishing valid from invalid reasoning but differ greatly in method, scope and application.

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Aristotelian Logic

Background:

- Aristotelian logic or Syllogistic logic ^{was} founded by Aristotle in works such as Prior Analytics.
- It is concerned with the relationship of terms.
- It focuses on categorical propositions and syllogisms.

Categorical Syllogism

A syllogism contains two premises and a conclusion. Three terms appear each exactly twice.

Major Term (P) - predicate of conclusion.

Minor Term (S) - Subject of conclusion

Middle Term (M) - Appears in both, not in conclusion.

Standard Form:

Major Premises $M - P$

Minor Premise: $S - M$

Conclusion: $S - P$

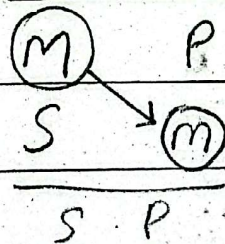
Example :

- 1) • All mammals are animals (All M are P)
 • All dogs are mammals (All S are M)
 - Therefore, All dogs are animals.
 (All S are P)

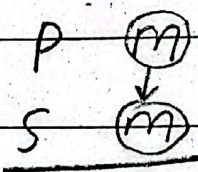
- 2) All men are mortal (All M are P)
 Socrates is a man (All S are M)
 Therefore, Socrates is mortal. (All S are P)

Figures of Syllogism

The position of middle term decides the figure of syllogism.

① 1st Figure :

All men are mortal
 Socrates is a man.
 $\therefore$ Socrates is mortal

② 2nd Figure

No politicians are professors
 Some doctors are professors
 $\therefore$ Some doctors are politicians.

③ 3rd Figure

$\begin{array}{c} (M) \ P \\ \downarrow \\ (M) \ S \end{array}$
 All poets are creative
 Some poets are philosophers
 $\therefore$ Some philosophers are creative.

④ 4th Figure

$\begin{array}{c} P \ (M) \\ \swarrow \\ (M) \ S \end{array}$
 All trees are plants
 All plants are alive
 $\therefore$ all trees are alive.

Categorical Propositions (AEIO)

A - Universal Affirmative

All men are mortal - All S are P.

E - Universal Negative

No birds are mammals - No S are P.

I - Particular Affirmative

Some students are intelligent -

Some S are P.

O - Particular Negative

Some animals are not carnivores - Some S are not P.

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Symbolic Logic

Background

The symbolic logic emerged in the 19th century with George Boole and Gottlob Frege.

It is shifted from terms to symbols and formal rules.

It became the foundation of mathematics, computer science, and philosophy of language.

Features

- Symbolic logic uses symbols to eliminate ambiguity of natural language.
- It deals with propositions, connectives and quantifiers.

Structure of Symbolic Logic

1) Propositional Logic

It deals with whole propositions without analyzing their internal

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structure. Each proposition is treated as a single unit and is either true or false.

- Capital letters like P, Q, R used as symbols to denote propositions.
- Logical connectives ($\neg, \wedge, \vee, \rightarrow$) to form compound propositions.

Example

P = It is raining

Q = The ground is wet

$P \rightarrow Q$ — If it rains, then the ground is wet

2) Predicate Logic

It goes beyond whole statements by examining their internal structures using predicates and variable.

Example

$\forall x (\text{human}(x) \rightarrow \text{Mortal}(x)) \rightarrow$ For all x ,
if x is human, then x is mortal.

Human (Socrates) $\rightarrow$ Socrates is a human

$\therefore$ Mortal (Socrates) $\rightarrow$ Therefore, Socrates is mortal.

3) Quantifiers

1) • Universal Quantifiers ($\forall$) :

means 'for all x or Every x '

Example

$\forall x (\text{Bird}(x) \rightarrow \text{CanFly}(x)) \rightarrow$

All birds can fly.

2) Existential Quantifier ($\exists$) :

means "There exists at least one x "

Example

$\exists x (\text{Prime}(x) \wedge \text{Even}(x)) \rightarrow$

There exists an x such that x is a prime and even.

Key Differences

Aristotelian

① Founder

Aristotle

Symbolic

Boole, Frege

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② Basic Unit

Term & Syllogism

Proposition/Predicate

③ Language

Natural language

Abstract symbols

④ Scope

Limited to syllogism

Handle all reasoning

⑤ Precision

Ambiguities possible

Unambiguous

⑥ Application

Philosophy, basic
reasoning

Math, AI,
formal sciences

⑦ Example

All men are mortal $\rightarrow$

$\forall x (\text{Men}(x) \rightarrow \text{Mortal}(x)) :$

Socrates is mortal

$\text{Man}(\text{socrates}) \rightarrow$

$\text{Mortal}(\text{socrates})$

Critical Evaluation

Aristotelian logic has historical significance: it trained minds in systematic thinking. Its simplicity makes it accessible, however, it is narrow in scope. Symbolic logic, on the

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other hand, revolutionized reasoning by creating a precise, formal system that can represent complex arguments, mathematical proofs. It is the logic of modern age.

Conclusion

In conclusion, Aristotelian logic laid the foundation of logical reasoning through syllogism and categorical propositions. Symbolic logic expanded this into a universal, precise system capable of handling modern science and technology.