Propositional Logic in AI

- Propositional logic (PL) is the simplest form of logic.

- All the statements are made by propositions.

- A proposition is a declarative statement which is either true or false.

- It is a technique of knowledge representation in logical and mathematical form.

- Examples:

    a) It is Sunday.

    b) The Sun rises from West (False proposition)

    c) 3+3= 7(False proposition)

    d) 5 is a prime number.

Propositional Logic in AI

- Propositional logic is also called Boolean logic as it works on 0 and 1.
- It uses symbolic variables to represent the logic, and can use any symbol for a representing a proposition, such A, B, C, P, Q, R, etc.
- Propositions can be either true or false, but it cannot be both.
- Propositional logic consists of an object, relations or function, and **logical connectives**.
- These connectives are also called logical operators.
- The propositions and connectives are the basic elements of the propositional logic.
- Connectives can be said as a logical operator which connects two sentences.
- A proposition formula which is always true is called **tautology**, and it is also called a valid sentence.
- A proposition formula which is always false is called **Contradiction**.
- Statements which are questions, commands, or opinions are not propositions such as "**Where is Rohini**", "**How are you**", "**What is your name**", are not propositions.

Types of Proposition

1. **Atomic Proposition**

   - Atomic propositions are the simple propositions. It consists of a single proposition symbol. These are the sentences which must be either true or false.

   - Examples:

     a) 2+2 is 4, it is an atomic proposition as it is a **true** fact.

     b) "The Sun is cold" is also a proposition as it is a **false** fact.

2. **Compound Proposition**

   - Compound propositions are constructed by combining simpler or atomic propositions, using parentheses and logical connectives.

   - Examples:

     a) "It is raining today, and street is wet."

     b) "Ankit is a doctor, and his clinic is in Mumbai."

Logical Connectives

1. **Negation:** A sentence such as ¬ P is called negation of P. A literal can be either Positive literal or negative literal.

2. **Conjunction:** A sentence which has ∧ connective such as, **P ∧ Q** is called a conjunction.
   Example: John is intelligent and hardworking. It can be written as,
   P= John is intelligent,
   Q= John is hardworking. → P∧ Q.

3. **Disjunction:** A sentence which has ∨ connective, such as **P ∨ Q**. is called disjunction, where P and Q are the propositions.
   Example: "Ritika is a doctor or Engineer",
   Here P= Ritika is Doctor. Q= Ritika is Doctor, so we can write it as **P ∨ Q**.

Logical Connectives

1. **Implication:** A sentence such as P → Q, is called an implication. Implications are also known as if-then rules. It can be represented as

   If it is raining, then the street is wet.

   Let P= It is raining, and Q= Street is wet, so it is represented as P → Q

2. **Biconditional:** A sentence such as **P⟺ Q is a Biconditional sentence, example If I am breathing, then I am alive**

   P= I am breathing, Q= I am alive, it can be represented as P ⟺ Q.

Logical Connectives

Connective symbols	Word	Technical term	Example
$\wedge$	AND	Conjunction	$A \wedge B$
$\vee$	OR	Disjunction	$A \vee B$
$\rightarrow$	Implies	Implication	$A \rightarrow B$
$\Leftrightarrow$	If and only if	Biconditional	$A \Leftrightarrow B$
$\neg$ or $\sim$	Not	Negation	$\neg A$ or $\neg B$

Truth Table for Negation

P	¬ P
True	False
False	True

Truth Table for Conjunction

P	Q	P∧Q
True	True	True
True	False	False
False	True	False
False	False	False

Truth Table for Disjunction

P	Q	P V Q.
True	True	**True**
False	True	**True**
True	False	**True**
False	False	**False**

Truth Table for Implication

P	Q	P→ Q
True	True	**True**
True	False	**False**
False	True	**True**
False	False	**True**

Truth Table for Biconditional

P	Q	P⇔ Q
True	True	**True**
True	False	**False**
False	True	**False**
False	False	**True**

P	Q	R	¬R	Pv Q	PvQ→¬R
True	True	True	False	True	False
True	True	False	True	True	True
True	False	True	False	True	False
True	False	False	True	True	True
False	True	True	False	True	False
False	True	False	True	True	True
False	False	True	False	False	True
False	False	False	True	False	True

Identify prepositions

1. France is a country.
2. 2020 will be a leap year.
3. Sun rises in the west.
4. P(x) : x + 6 = 7
5. P(5) : 5 + 6 = 2
6. Apples are oranges.
7. Grapes are black.
8. Two and two makes 4.
9. x > 10
10. Open the door.
11. Are you tired?
12. What a bright sunny day!
13. Mumbai is in India.
14. I always tell truth.
15. Do not go there.
16. This sentence is true.
17. It will rain tomorrow.
18. Fan is rotating.