

1. Propositional Logic

Propositions are statements that are either True (T) or False (F). Let P and Q be propositions.

- **Negation** ($\neg P$): Opposite truth value.
- **Conjunction** ($P \wedge Q$): True only if *both* are True.
- **Disjunction** ($P \vee Q$): True if *at least one* is True.
- **Implication** ($P \implies Q$): False only if P is True and Q is False.
- **Biconditional** ($P \iff Q$): True if both have the same truth value.

Truth Table Quick Reference

P	Q	$P \wedge Q$	$P \vee Q$	$P \implies Q$
T	T	T	T	T
T	F	F	T	F
F	T	F	T	T
F	F	F	F	T

2. Logical Equivalences

- **Contrapositive:** $P \implies Q \equiv \neg Q \implies \neg P$
- **Converse:** $Q \implies P$ (Not equivalent to original!)
- **Inverse:** $\neg P \implies \neg Q$
- **De Morgan's Laws:**

$$\neg(P \wedge Q) \equiv \neg P \vee \neg Q$$

$$\neg(P \vee Q) \equiv \neg P \wedge \neg Q$$

- **Distributive Laws:**

$$P \vee (Q \wedge R) \equiv (P \vee Q) \wedge (P \vee R)$$

3. Syllogisms

A syllogism is a kind of logical argument that applies deductive reasoning to arrive at a conclusion based on two or more propositions that are asserted or assumed to be true.

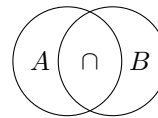
Example:

Premise 1: All humans are mortal.

Premise 2: Socrates is a human.

Conclusion: Socrates is mortal.

Venn Diagram Interpretation



4. Quantifiers

- **Universal** ($\forall$): "For all". $\forall x P(x)$
- **Existential** ($\exists$): "There exists". $\exists x P(x)$
- **Negation of Quantifiers:**

$$\neg(\forall x P(x)) \equiv \exists x \neg P(x)$$

$$\neg(\exists x P(x)) \equiv \forall x \neg P(x)$$

5. Logical Fallacies

Common errors in reasoning that invalidate an argument:

- **Ad Hominem:** Attacking the arguer instead of the argument.
- **Strawman:** Misrepresenting an argument to make it easier to attack.
- **False Dilemma:** Presenting only two options when more exist.
- **Post Hoc Ergo Propter Hoc:** Assuming causation from correlation.