

# Roles of Illustrations in Propositional Logic Textbooks

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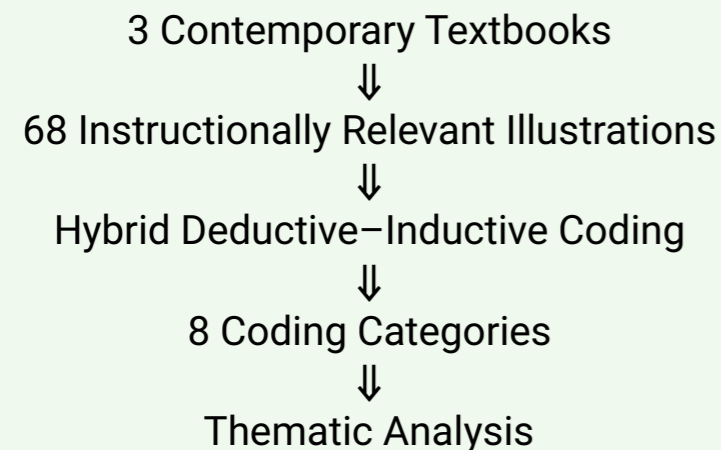
## Related Work

- Diagrammatic reasoning can make logical relations perceptually accessible [1].
- Logic diagrams function as cognitive tools that support reasoning through visual structure [2].
- Logical diagrams can also be analysed as specialised visualisations with properties such as correctness and legibility [3].
- However, little attention has been paid to the illustrations students actually encounter in contemporary logic textbooks.
- This study examines how contemporary textbooks use illustrations and what pedagogical and communicative roles they perform.

## Research Question

How do illustrations function pedagogically in propositional logic textbooks?

## Methodology



## Corpus

- *Logic in Computer Science* (Huth & Ryan)
- *Introduction to Mathematical Logic* (Mendelson)
- *Delftse Foundations of Computation* (Hugtenburg & Yorke-Smith)

Selected because they represent different educational contexts while sharing coverage of propositional logic.

## Codebook Overview

Category	Purpose
Type	visual form
Role	communicative function
Context	instructional setting
Abstraction	abstract/concrete/hybrid
Reference	text-image linkage
Signaling	interpretive guidance
Spatial Contiguity	layout relationship

## Theme 1: Illustrations as translations and definitions of propositional logic

- Truth tables, parse trees (Figure 1a), and logic circuits re-express symbolic logic in visual form.
- In many cases, they do not merely illustrate concepts but define them (e.g., truth tables, see Figure 1b).
- Visual representations are tightly integrated with surrounding explanatory text.
- Symbolic and visual systems function as a unified representational structure.

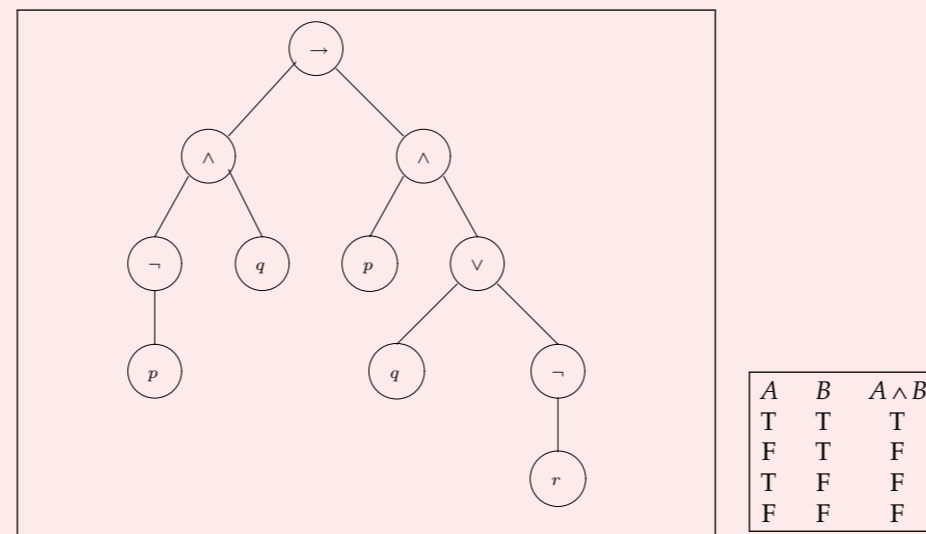


Figure 1.3. A parse tree representing a well-formed formula.

Figure: a: Parse tree representation of  $((((\neg p) \wedge q) \rightarrow (p \wedge (q \vee (\neg r))))$   
 b: Truth table defining conjunction.

A	B	$A \wedge B$
T	T	T
F	T	F
T	F	F
F	F	F

## Theme 2: Consistent illustration choices support different aspects of propositional logic

Textbook	Supported reasoning
Hugtenburg	Computational realisation (circuits, binary operations, see Figure 2)
Huth	Syntactic structure and algorithmic reasoning (parse trees, DAGs, SAT)
Mendelson	Semantic definition and formal proof (truth tables)

- Illustration choice systematically aligns with reasoning type.
- Visual representations are not interchangeable: they encode epistemic priorities.
- Textbooks implicitly define “what doing logic means” through visuals.

A	B	C	output	A	B	C	output
0	0	0	0	0	0	0	0
0	0	1	1	0	0	1	0
0	1	0	1	0	1	0	0
0	1	1	0	0	1	1	1
1	0	0	1	1	0	0	0
1	0	1	0	1	0	1	1
1	1	0	0	1	1	0	1
1	1	1	1	1	1	1	1

Figure 2.8: Input/output tables for the addition of three binary digits, A, B, and C.

Figure: Binary addition truth tables.

## Limitations and Future Work

- Limited corpus → Larger textbook corpora (e.g. across educational levels, institutions, cultures, or historical periods)
- One area of logic → Other logic domains such as predicate logic and modal logic
- Single researcher → Collaborative coding
- Student interpretation and learning studies

## Key Takeaways

- Illustrations function as translations of symbolic expressions and sometimes definitions of formal concepts.
- Different illustration types consistently support different forms of logical reasoning.
- They shape how logic is presented and framed within textbook discourse.

## Key References

[1] J. Bernard. “Can We “Show” the Correctness of Reasoning? On the Role of Diagrammatic Spatialization in Logical Justification”. In: *When Form Becomes Substance: Power of Gestures, Diagrammatical Intuition and Phenomenology of Space*. Cham: Springer International Publishing, 2022, pp. 27–64. ISBN: 9783030831257. doi: 10.1007/978-3-030-83125-7\_2.

[2] R. Bhattacharjee. “Visual Clarity and Expressiveness in Logic Diagrams”. In: *Logica Universalis* 19.2 (Sept. 1, 2026), pp. 329–344. ISSN: 1661-8300. doi: 10.1007/s11787-025-00375-5.

[3] R. Bolz. “Logical Diagrams, Visualization Criteria, and Boolean Algebras”. In: *The Exoteric Square of Opposition*. Cham: Springer International Publishing, 2022, pp. 195–224. ISBN: 9783030908232. doi: 10.1007/978-3-030-90823-2\_9.