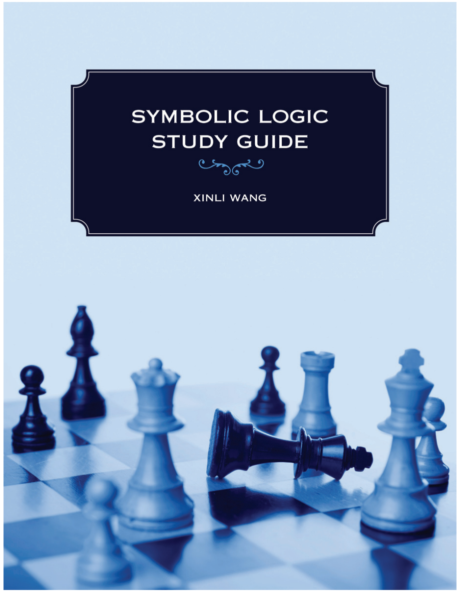


# Symbolic Logic Study Guide

By Xinli Wang

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# SYMBOLIC LOGIC STUDY GUIDE

**Designed to accompany the textbook *Language, Proof and Logic*, by Jon Barwise and John Etchemendy, CSLI Publications 2003**


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# PART I: CLASS NOTES

This part contains the instructor's class notes for the course.

## Section 1: Introduction (refer to pp. 1-10, 2.1 of LPL)

### 1. What is logic?

**Arguments**

(1) Some examples of arguments

Mary will marry John *only if* John loves her.
John loves Mary.

---

Therefore, Mary will marry John.

All human beings are mortal.
Socrates is a human being.

---

Therefore, Socrates is mortal.

If you can win the game, I would be the uncle of a monkey.
......

---

(Therefore, you will not win the game.)

I will die if I am killed.
I am not killed.

---

Therefore, I will not die.

All the students in the room are logic students.
Some logic students are really boring.

---

Some students in the room are boring.

Swan a is white.
Swan b is white.
......
Swan n is white.

---

Therefore, all swans are white.

(2) Components of arguments

Definition: An argument is a group of statements, one or more of which (the premises) are claimed to provide support for, or reasons to believe, one of the others (the conclusion).

The structure of an argument:

Premise 1
Premise 2
___________ support
Conclusion

Premises provide some grounds (not necessarily guarantee) for the truths of the conclusion. There is an inferential relationship between premises and conclusion.

(3) Deductive vs. Inductive Arguments: …

**A definition:**

Logic is the study of the methods and principles used to distinguish good / cogent from bad /fallacious argument.

**2. How to evaluate (deductive) arguments: validity and soundness**

**Two basic criteria of evaluation**

An Argument → Validity--the inferential relationship between Ps and C: Whether Ps support C and to what extent?

An Argument → Soundness—the status of premises: whether Ps are true or acceptable?

A good argument: (a) All Ps are acceptable (true) and (b) Ps support C to the extent that if all Ps are true, then it is impossible for C to be false.

**Validity**

Definitions:

- An Argument is valid if and only if it is *logically impossible* for the conclusion to be false if all the premises to be true.
- An argument is valid iff the truths of the premises guarantee the truth of the conclusion.

A few feature of validity:

- Truth-preserving: from the truth of the premises to the truth of the conclusion.

premises $\xRightarrow{\text{Truth}}$ conclusion

- Hypothetical situation: Suppose / assume that all the premises are true, not that all the premises are actually true. For example, the following argument is valid although all the premises are actually false:

All cats are sea creatures. (False)
All sea creatures are clod-blooded killers. (False)

---

All cats are cold-blooded killers. (False)

- All or nothing issue: validity has no degree.
- Validity of an argument is determined by the *form* of the argument only (the inferential relation between the conclusion and the premises). Validity of an argument has nothing to do with the *contents*, and therefore the actual truth-values, of the premises and the conclusion.

Examples:

**Argument Form** | **Arguments in English**

**Valid Form**

All S are M
All M are P

---

All S are P

All cats are sea creatures. (F)
All sea creatures are blue. (F)

---

All cats are blue. (F)

All cats are sea creatures. (F)
All sea creatures are mammals. (F)

---

All cats are mammals. (T)

All cats are mammals. (T)
All mammals are animals. (T)

---

All cats are animals. (T)

**Invalid Form**

All S are M
All P are M

---

All S are P.

All cats are mammals. (T)
All dogs are mammals. (T)

---

All cats are dogs. (F)

All cats are sea creatures. (F)
All dogs are sea creatures. (F)

---

All cats are dogs. (F)

All cats are animals. (T)
All mammals are animals. (T)

---

Al cats are mammals. (T)

All cats are females. (F)
All mammals are females. (F)

---

All cats are mammals. (T)

**Soundness**

Definition: An argument is sound iff it is valid and all its premises are true.

Soundness = validity + truth of Ps.

**3. How to determine whether an argument is valid?**
Two steps of evaluation of validity:

Step I—**Symbolization / translation**: symbolize arguments in English into logical notation.

Example:

| **Argument in English** | **Argument in Logical notions** |
| --- | --- |
| Mary will marry John *only if* John loves her.<br>John loves Mary. | Marry (Mary, John) $\rightarrow$ Love (John, Mary)<br>Love (John Mary) |
| Therefore, Mary will marry John. | Marry (Mary, John) |
| | $M \rightarrow L$<br>$L$ |
| | $M$ |
| All the students in the room are logic students.<br>Some logic students are really boring. | $\forall x\ [(S\ (x) \wedge I\ (x)) \rightarrow L\ (x)]$<br>$\exists x\ [L\ (x) \wedge B\ (x)]$ |
| Some students in the room are boring. | $\exists x\ [(S\ (x) \wedge I\ (x)) \wedge B\ (x)\ ]$ |

Step II—**Formal proof**: using some formal methods to determine the validity of the argument in logical notion.

Formal methods
- truth-tree method
- truth-table method
- natural derivation