

Symbolic Logic Study Guide

By Xinli Wang

Included in this preview:

- **Copyright Page**
- **Table of Contents**
- **Excerpt of Chapter 1**

For additional information on adopting this book for your class, please contact us at 800.200.3908 x71 or via e-mail at info@universityreaders.com

SYMBOLIC LOGIC STUDY GUIDE

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

By Xinli Wang, Ph.D.

Juniata College



University Readers™

San Diego, CA

Copyright © 2009 by Xinli Wang. All rights reserved. No part of this publication may be reprinted, reproduced, transmitted, or utilized in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information retrieval system without the written permission of University Reader Company, Inc.

First published in the United States of America in 2009 by University Reader Company, Inc.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

13 12 11 10 09

1 2 3 4 5

Printed in the United States of America

ISBN: 978-1-934269-79-4



University Readers™

800.200.3908 | www.universityreaders.com

TABLE OF CONTENTS

Part I: Class Notes	1
Section 1: Introduction	1
Section 2: Atomic Sentences.....	5
2.1. The Basic Structure of Atomic Sentences	5
2.2. Translating Simple English Sentences into Logical Notation.....	9
2.3. Methods of Proof	10
2.4. Formal Proofs	13
Section 3: Conjunctions, Disjunctions, and Negations.....	16
3.1. Introduction to Conjunctions, Disjunctions, and Negations	16
3.2. Logical Equivalency	19
3.3. Translation	22
3.4. Formal Proofs	24
Section 4: Conditionals and Biconditionals.....	30
4.1. Material Conditional/Biconditional Symbols.....	30
4.2. Formal Proofs Involving the Conditional	33
Section 5: Introduction to Quantification	36
5.1. Basic Components of FOL	36
5.2. Semantics for the Quantifiers	39
5.3. Translation of Sentences with Quantifiers	41
5.4. Logical Equivalence Involving Quantifiers	47
5.5. Multiple Quantifiers.....	54
Section 6: Formal Proofs Involving Quantifiers	59
Section 7: Some Specific Uses of Quantifiers	62
7.1. Numerical Claims	62
7.2. Definite Descriptions	65
Part II. Practice Quizzes	67
Section 1: Quizzes	67
Quiz One	67
Quiz Two.....	68
Quiz Three.....	69
Quiz Four	70
Quiz Five.....	72
Quiz Six.....	73
Quiz Seven	74
Quiz Eight	75

Quiz Nine	76
Quiz ten	77
Quiz Eleven	78
Quiz Twelve	79
Section 2: Solutions to Quizzes.....	81
Quiz One Solutions	81
Quiz Two Solutions	82
Quiz Three Solutions	83
Quiz Four Solutions	84
Quiz Five Solutions.....	86
Quiz Six Solutions	87
Quiz Seven Solutions	88
Quiz Eight Solutions	90
Quiz Nine Solutions	91
Quiz Ten Solutions	93
Quiz Eleven Solutions.....	97
Quiz Twelve Solutions.....	99

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.

.....

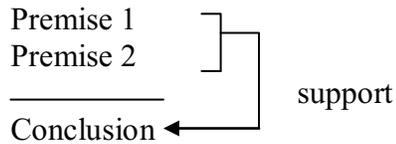
Swan n is white.

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:



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

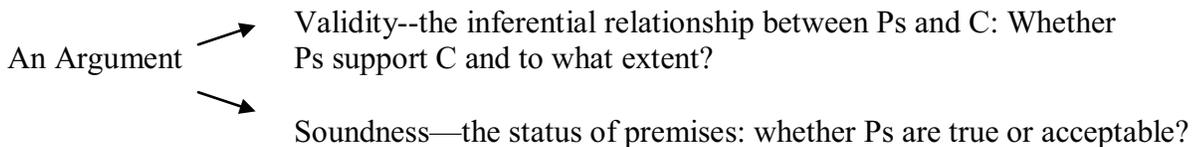
(3) Deductive vs. Inductive Arguments: ...

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



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.

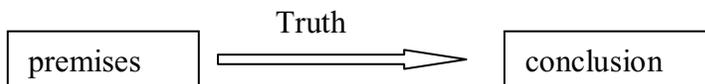
Validity

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.



- 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 cold-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:

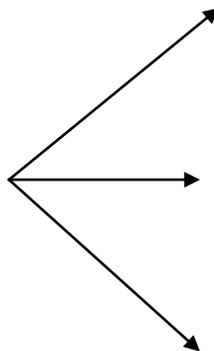
Argument Form

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)

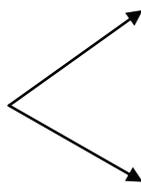
All cats are mammals. (T)
 All mammals are animals. (T)

 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 sea creatures. (F) All dogs are sea creatures. (F)
All cats are dogs. (F)	All cats are dogs. (F)
All cats are animals. (T) All mammals are animals. (T)	All cats are females. (F) All mammals are females. (F)
All cats are mammals. (T)	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

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

Therefore, Mary will marry John.

Argument in Logical notions

Marry (Mary, John) \rightarrow Love (John, Mary)
Love (John Mary)

Marry (Mary, John)

$M \rightarrow L$

L

M

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

Some students in the room are boring.

$\forall x [(S(x) \wedge I(x)) \rightarrow L(x)]$

$\exists x [L(x) \wedge B(x)]$

$\exists x [(S(x) \wedge I(x)) \wedge B(x)]$

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