Intermediate Logic

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Introductory Logic

For Christian and Home Schools

Fourth Edition
Revised and Expanded

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&
Douglas J. Wilson

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Unit Two: Formal Proofs of Validity

Unit Three: Truth Trees

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PREFACE TO THE FIRST EDITION

This text is designed as a continuation to *Introductory Logic*, which I co-authored with Douglas Wilson. Together, these two textbooks should provide sufficient material for a complete, first-year course in elementary logic.

I have attempted to make this a useable workbook for the logic student. To that end I have included exercises for every lesson which I have developed and used over many years of teaching logic. I have also made it my goal to write this text clearly and completely, such that an adult could teach himself the fundamentals of logic.

While writing *Intermediate Logic* I regularly consulted a number of other excellent logic textbooks. Most helpful has been Irving Copi's invaluable *Introduction To Logic* (Macmillan Publishing Co., 1978), which was the textbook for my first logic course at Washington State University. While doing my best to not lift material directly from it, that book has so shaped my own understanding of this subject that I undoubtedly echo much of its format and contents. I have also benefitted from *The Art of Reasoning* by David Kelley (W. W. Norton & Company, Inc., 1990) and *The Logic Book* by Bergmann, Moor and Nelson (McGraw-Hill, Inc., 1990).

I am indebted to many people for the completion of this project. I am thankful for the encouragement and example of my pastor, Doug Wilson, who helped me to understand the beauty and practicality of logic. I am also thankful for Chris Schlect, who has regularly spurred me on toward completing this book (though he undoubtedly would have written it quite differently) and has always encouraged me to think through my understanding of the subject. The administrators of Logos School, Tom Garfield and Tom Spencer, have given me assistance and encouragement. My patient and ever-cheerful editor, Doug Jones, has always been there for me to bounce ideas off of. I owe special credit to my students throughout the years to whom I have had the true pleasure of introducing the world of logic. They have always forced me to re-evaluate my own understanding of the subject and have contributed more to this book than I or they realize.

Finally and most importantly I thank God for my lovely wife Giselle, who has proofread the text and worked through every lesson. To her this book is dedicated.

James B. Nance
January 1996

PREFACE TO THE SECOND EDITION

The subject of logic may be divided into two main branches: formal and informal. The definition of logic as "the science and the art of correct reasoning" allows us to distinguish these two branches. Formal logic deals *directly* with reasoning. Reasoning means "drawing conclusions from other information." Whenever we consider how to analyze and write logical arguments—in which conclusions are drawn from premises—we are working in the realm of formal logic. Informal logic, on the other hand, deals more *indirectly* with reasoning. When we argue, we often find ourselves defining terms, determining the truth values of statements, and detecting spurious informal fallacies. While in none of these activities do we concentrate on reasoning in a formal way, we do recognize that such activities are indirectly related to and support the process of reasoning, and are thus best included under informal logic.

With this in mind, several changes have been made in this second edition of *Intermediate Logic*.

First, in order to present to the student a more logical progression of topics, the section on defining terms from the first edition has been entirely removed from this text and placed at the beginning of *Introductory Logic*, where it is taught along with other branches of informal logic and categorical logic. Consequently, this text now focuses solely on the branch of formal logic called propositional logic, of which formal proofs of validity and truth trees are subsets.

Second, review questions and review exercises have been added to each unit for every lesson in the text, effectively doubling the number of exercises for students to verify their knowledge and develop their understanding of the material. Additionally, some especially challenging problems which relate to the material have been included in the review exercises. Students who can correctly answer all of the review questions demonstrate a sufficient knowledge of the important concepts. Students who can correctly solve the review exercises demonstrate a sufficient understanding of how to apply those concepts.

Third, the definitions of important terms, key points made, and caution signs regarding common errors are now set apart in the margins of the text. This should help students to distinguish the most important topics, as well as aid in their review of the material.

Fourth, every lesson has been reviewed in detail with the goal of improving the clarity of the explanations and correcting several minor errors that were found in the first edition. To all of my former logic students at Logos School, teachers and students of logic at other schools who used the first edition, and the editors at Canon Press who have taken the time to point out mistakes and suggest areas for improvement, I offer my sincerest thanks. To all of them goes the credit for any improvements that have been made in this second edition; for those remaining errors and defects I take full responsibility.

James B. Nance
January 2006

Introduction

Logic has been defined both as the *science* and the *art* of correct reasoning. People who study different sciences observe a variety of things: biologists observe living organisms, astronomers observe the heavens, and so on. From their observations they seek to discover natural laws by which God governs His creation. The person who studies logic as a science observes the mind as it reasons—as it draws conclusions from premises—and from those observations discovers laws of reasoning which God has placed in the minds of people. Specifically, he seeks to discover the principles or laws which may be used to distinguish good reasoning from poor reasoning. In deductive logic, good reasoning is *valid* reasoning—in which the conclusions follow necessarily from the premises. Logic as a science discovers the principles of valid and invalid reasoning.

Logic as an *art* provides the student of this art with practical skills to construct arguments correctly as he writes, discusses, debates, and communicates. As an art logic also provides him with rules to judge what is spoken or written, in order to determine the validity of what he hears and reads. Logic as a science discovers rules. Logic as an art teaches us to apply those rules.

Logic may also be considered as a symbolic language which represents the reasoning inherent in other languages. It does so by breaking the language of arguments down into symbolic form, simplifying them such that the arrangement of the language, and thus the reasoning within it, becomes apparent. The outside, extraneous parts of arguments are removed like a biology student in the dissection lab removes the skin, muscles and organs of a frog, revealing the skeleton of bare reasoning inside. Thus revealed, the logical structure of an argument can be examined, judged and, if need be, corrected, using the rules of logic.

So logic is a symbolic language into which arguments in other languages may be translated. Now arguments are made up of propositions, which in turn are made up of terms. In categorical logic, symbols (usually capital letters) are used to represent terms. Thus "All men are sinners" is translated "All M are S." In propositional logic, the branch of logic with which this book primarily deals, letters are used to represent entire propositions. Other symbols are used to represent the logical operators which modify or relate those propositions. So the argument, "If I don't eat, then I will be hungry; I am not hungry, so I must have eaten" may appear as $\sim E \supset H$, $\sim H$, $\therefore E$.

Unit I of this book covers the translation and analysis of such propositional arguments, with the primary concern of determining the validity of those arguments. Unit 2 introduces a new kind of logical exercise: the writing of formal proofs of validity and related topics. Unit 3 completes propositional logic with a new technique for analyzing arguments: truth trees.

Unit One

Propositional Logic

Contents

Lesson 1

INTRODUCTION TO PROPOSITIONAL LOGIC

Propositional logic is a branch of formal, deductive logic in which the basic unit of thought is the propositon. A **proposition** is a statement, a sentence which has a truth value. A single proposition can be expressed by many different sentences. The following sentences all represent the same proposition:

God loves the world.
The world is loved by God.
Deus mundum amat.

These sentences represent the same proposition because they all have the same meaning.

In propositional logic, letters are used as symbols to represent propositions. Other symbols are used to represent words which modify or combine propositions. Because so many symbols are used, propositional logic has also been called "symbolic logic." Symbolic logic deals with **truth-functional propositions**. A proposition is truth-functional when the truth value of the proposition depends upon the truth value of its component parts. If it has only one component part, it is a **simple proposition**. A categorical statement is a simple proposition. The proposition *God loves the world* is simple. If a proposition has more than one component part (or is modified in some other way), it is a **compound proposition**. Words which combine or modify simple propositions in order to form compound propositions (words such as *and* and *or*) are called **logical operators**.

For example, the proposition *God loves the world and God sent His Son* is a truth-functional, compound proposition. The word *and* is the logical operator. It is truth functional because its truth value depends upon the truth value of the two simple propositions which make it up. It is in fact

Definitions

Propositional logic is a branch of formal, deductive logic in which the basic unit of thought is the proposition. A *proposition* is a statement.

Key Point

One proposition may be expressed by many different sentences.

Definition

A proposition is *truth-functional* when its truth value depends upon the truth values of its component parts.

Definition

If a proposition has only one component part, it is a *simple proposition*. Otherwise, it is *compound*.

a true proposition, since it is true that God loves the world, and it is true that God sent His Son. Similarly, the proposition *It is false that God loves the world* is compound, the phrase *it is false that* being the logical operator. This proposition is also truth-functional, depending upon the truth value of the component *God loves the world* for its total truth value. If *God loves the world* is false, then the proposition *It is false that God loves the world* is true, and vice versa.

Definition

Logical operators are words which combine or modify simple propositions to make compound propositions.

However, the proposition *Joe believes that God loves the world,* though compound (being modified by the phrase *Joe believes that),* is *not* truth-functional, because its truth value does not depend upon the truth value of the component part *God loves the world.* The proposition *Joe believes that God loves the world* is a self-report and can thus be considered true, regardless of whether or not *God loves the world* is true.

Definitions

A *propositional constant* is an uppercase letter that represents a single, given proposition. A *propositional variable* is a lowercase letter that represents any proposition.

When a given proposition is analyzed as part of a compound proposition or argument, it is usually abbreviated by a capital letter, called a **propositional constant**. Propositional constants commonly have some connection with the propositions they symbolize, such as being the first letter of the first word, or some other distinctive word within the proposition. For example, the proposition *The mouse ran up the clock* could be abbreviated by the propositional constant M. On the other hand, *The mouse did not run up the clock* may be abbreviated ~M (read as *not M*). Within one compound proposition or argument, the same propositional constant should be used to represent a given proposition. Note that a simple proposition cannot be represented by more than one constant.

When the *form* of a compound proposition or argument is being emphasized, we use **propositional variables.** It is customary to use lowercase letters as propositional variables, starting with the letter p and continuing through the alphabet (q, r, s, . . .). Whereas a propositional constant represents a single, given proposition, a propositional variable represents an unlimited number of propositions.

Key Point

A propositional constant or variable can represent a simple proposition or a compound proposition.

It is important to realize that a single constant or variable can represent not only a simple proposition but also a compound proposition. The variable p could represent *God loves the world* or it could represent *God loves the world but He hates sin.* The entire compound proposition *It is false that if the mouse ran up the clock, then, if the clock did not strike one, then the mouse would not run down* could be abbreviated by a single constant F, or it could be represented by symbolizing each part, such as $\sim(M \supset (\sim S \supset \sim D))$. The decision concerning how to abbreviate a compound proposition depends on the purpose for abbreviating it. We will learn how to abbreviate compound propositions in the next few lessons.

SUMMARY

A proposition is a statement. Propositions are truth-functional when the truth value of the proposition depends upon the truth value of its component parts. Propositions are either simple or compound. They are compound if they are modified or combined with other propositions by means of logical operators. Propositional constants are capital letters which represent a single given proposition. Propositional variables are lower case letters which represent an unlimited number of propositions.

EXERCISE 1

What are two main differences between propositional constants and propositional variables?

1. ______________________________

2. ______________________________

Modify or add to the simple proposition *We have seen God* to create the following:

3. A truth-functional compound proposition: ______________________________

____

4. A proposition which is *not* truth-functional: ______________________________

____

Circle *S* if the given proposition is simple. Circle *C* if it is compound.

5. The Lord will cause your enemies to be defeated before your eyes. S C
6. There is a way that seems right to a man but in the end it leads to death. S C
7. The fear of the Lord is the beginning of wisdom. S C
8. If we confess our sins then He is faithful to forgive us our sins. S C
9. It is false that a good tree bears bad fruit and that a bad tree bears good fruit. S C
10. The Kingdom of God is not a matter of talk but of power. S C

Given that B means *The boys are bad* M means *The man is mad*
G means *The girls are glad* S means *The students are sad*

Translate the following compound propositions:

11. It is false that B. ______________________________

12. B or G. ______________________________

13. B and M. ______________________________

14. If M then S. ______________________________

15. If not M and not S then G.______________________________

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