

PHL 282
Introduction to Symbolic Logic (Formal Logic I)
FALL 2015
DEPAUL UNIVERSITY

Instructor: Daniel Rosiak,

Time and Location: Tuesdays, Thursdays 11:00-12:50pm, 2352 N Clifton (the Philosophy building), Room 145

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Overview and Objectives

Logic is vital to nearly all domains of inquiry, and while it began as one of the principal branches of philosophy with Aristotle, today it is a subject with a large number of applications. This course is designed to provide the student with a strong introduction to symbolic (formal) logic, which means that the student will learn how to formalize or represent arguments and reasoning in symbolic languages, the symbols of which are used to schematically break down arguments into their logical structure and are manipulated according to precisely defined rules of inference. Students will learn to model everyday reasoning and arguments using a formal language. This will involve first of all learning how to translate back and forth between English sentences/arguments and systems of symbols; students will learn what makes an argument a *good* argument and will get practice identifying these in everyday life (and detecting when an argument isn't good!). We will then develop certain formal systems in which setting we can more readily model and determine whether or not an argument has "good form" (is valid). While logic is basically the study of what makes reasoning/thinking good—something that many of you may already have a decent intuitive sense for—the real power of logic comes from the *formalization* of this process. This is a very valuable step in itself, and can be quite enjoyable! But it is also something that has a number of important advantages, e.g., in terms of improving your ability to examine arguments critically in your other courses, preparing you for a number of graduate school exams and tests like the LSAT, making it easier to think clearly about problems, helping you separate which claims made in everyday life and the media are backed up by good reasoning and which are not, etc. You will leave this course with a number of very valuable skills that you will undoubtedly use for the rest of your life, regardless of your chosen path.

We will begin the course (week 1) playing some logic games and puzzles together—which are a lot of fun, provide an engaging way of introducing or reinforcing the fundamentals of logical thinking, and will even be used to give you a glimpse into some of the deeper conundrums about logic and reasoning itself. We will then spend a week (week 2) on some informal approaches to reasoning, including how to identify various common logical fallacies

and pitfalls of argumentation, both in general and as applied to some conspicuous cases in the media. This will also motivate the turn to a *formal* approach to these matters. The rest of the first half of the course (weeks 3-6) will be dedicated to covering the basics of our *formal* system, sentential (or propositional) logic; getting a good sense of fundamental “meta-logical” concepts (such as the syntax and semantics of our formal language), where these get at what we are even “doing” in this enterprise of modeling and assessing arguments by means of a given formal language; and, most importantly, learning how to *prove* things within our language, specifically by working with both natural deduction and tree methods of proof (you will see what these are shortly). Sentential logic basically formalizes reasoning involving propositional connectives like ‘and’, ‘or’, ‘not’, and ‘if..., then’. You will develop a strong facility with reasoning formally with such things.

After the midterm, we will cover (week 7) a few important results *about* the formal system we have been using, i.e., we will cover some important results in “metatheory” (specifically soundness and completeness, and compactness). This material is a little more “difficult” than the material covered in the rest of the course, so I will not hold you accountable for it on the final (however there will be exercises paired with these lessons). These lessons are important not only for giving the student a better sense of the true powers and limitations of the formal system, but also for beginning to think a bit about some of the deeper and “bigger picture” philosophical questions lurking in the construction of formal systems. The student will also have a better contextual understanding of these results, by getting a glimpse of the ideas behind some of the more mysterious *incompleteness* and *undecidability* phenomena that crop up in other contexts. Learning a little about some of the fascinating metatheoretical results will also especially appeal to philosophy students and anyone interested in the “bigger picture,” and will give students a glimpse of a small fragment of the large number of thought-provoking questions and remarkable results that go to the core of what is knowable.

We will then introduce quantifiers to our toolbox—quantifiers are basically symbols used to state ‘how many’, i.e., one used to assert that *all* entities have some property and another to assert that *some* (at least one) has some property. Quantifiers will make our formal system much more fine-grained and powerful, allowing us to do things we couldn’t do before, e.g., to represent and prove the validity of a number of valid arguments that would have been invalid when symbolized in the (rather meager) notation of propositional logic. The resulting logic, using quantifiers, is called predicate (*first-order*) logic, and we will spend most of the last third of the course (weeks 8-11) learning how to work with, and prove things within, this logic.

The course will conclude with a very brief look at some of the powerful applications of logic—in everyday life and beyond—as well as some of the limitations of the systems we developed, which will motivate discussion of some of the fascinating further developments and philosophical questions that emerge in this context and beyond.

Requirements

- **Exercises:** you will be responsible for completing problem sets as homework for *each class meeting*, which together make up **40%** of your final grade in the course

- **Midterm** on 10/20 (**25%** of final grade)
- **Final Exam** on 11/23 (**25%** of final grade)
- **Participation/Attendance** (**10%** of final grade)

Course Materials

- **Required**

The main textbook we will use in this course is

- Hausman, A., Kahane, H., and Tidman, P. *Logic and Philosophy: A Modern Introduction*. Cengage Learning, 12 edition edition

but some exercises and select reading assignments will come from other sources, which will be posted to D2L, including

- **Made available to you on D2L**

- Selections from Raymond Smullyan’s *What is the Name of this book?* and *Logical Labyrinths*
- Selections from Irving Copi’s *Introduction to Logic*
- My “Basic Concepts in Logic: Some History, Fundamentals of Arguments, and Important Distinctions”
- My “Lecture Notes on Background and Bigger Picture of Metatheoretical Results concerning Propositional Logic”
- My handout “Where to go after learning basic logic?”

Course Outline

*Note: As for the exercises, you are only held accountable for the **odd-numbered problems** in each of “Exercise” problem sets from Hausman. You are of course welcome to do some or all of the even-numbered exercises—note that the answers to these are in the back of the book, so you can check your work on these before moving on to the odd-numbered ones. Any other Exercise assignment (not coming from exercises in the Hausman text) requires that you answer all of the questions (unless otherwise noted).*

*The readings and exercises are the homework for each designated class meeting—so an Exercise and Reading assigned under the 9/10 class heading are to be **completed** by the beginning of the next class meeting on 9/15.*

The Basics (Weeks 1-3)

- 9/10: Course Introduction; Some Logic Riddles, Liars and Truth-Tellers; Some basic concepts
Reading: Smullyan *Selection 1*, on D2L
Exercises: *Knights and Knaves Questions*, assignment on D2L
- 9/15: Some history of logic; fundamentals of reasoning and arguments; the three argument types; some fallacies; discussion of the need for (and some history behind) formalization
Reading: Re-read my “Basic Concepts in Logic: Some History, Fundamentals of Arguments, and Important Distinctions” slides posted on D2L
Exercises: Answer the 5 questions on the “Basic Concepts Assignment 1”
- 9/17: Applications of basic concepts to everyday arguments; practice detecting fallacies and analyzing arguments by unpacking “arguments” made in the media
Reading: following the instructions in “Some common fallacies,” identify 3 short “arguments” from any of the media source options listed in that document
Exercises: analyze the 5 passages/quotes given in “Some common fallacies” and then do the same thing for the 3 you selected as well
- 9/22: Basics of sentential/propositional logic (PL); introducing syntax and semantics; connectives and translation
Reading: [Hausman et al., , Chapter 2]
Exercises: 2-6, 2-7, 2-9 in Hausman
- 9/24: PL continued; more on connectives; truth and valid argument forms; truth-tables introduced
Reading: [Hausman et al., , Chapter 3];
Exercises: 3-1, 3-2, 3-3, 3-4, 3-5 in Hausman
- 9/29: Key concepts introduced: tautologies/theorems; logical equivalence; consistency; truth-table tests for validity and invalidity; satisfiability
Reading: [Hausman et al., , Chapter 3 continued]; [Rosiak, “Lecture Notes on Background...,” pages 1-7]
Exercises: 3-7, 3-8, 3-9, 3-10 in Hausman

Proofs and Metatheory (Weeks 4-7)

- 10/01: Natural deduction proofs
Reading: [Hausman et al., , Chapter 4]; Copi *Selection 1* on D2L
Exercises: 4-2, 4-5, 4-8 in Hausman

- 10/06: Proofs continued and some calisthenics
Reading: [Hausman et al., , Chapter 4 continued]
Exercises: 4-10, 4-12, 4-13; additional exercise in “More Proofs Handout” on D2L
- 10/08: Conditional and Indirect Proofs
Reading: [Hausman et al., , Chapter 5]
Exercises: 5-2, 5-3, 5-5 in Hausman
- 10/13: Theorem Proving
Reading: [Hausman et al., , Chapter 5 continued]
Exercises: 5-6, 5-7 in Hausman; problems from “Handout on Theorem Proving” on D2L
- 10/15: Truth Trees, Truth Functions and Truth-Functional Completeness
Reading: [Hausman et al., , Chapter 6]; [Rosiak, “Lecture Notes...”, pages 8-14]
Exercises: Problems from “Lecture Notes” on page 14
- 10/20 A little more on trees; Midterm review!
Reading: Midterm Review Handout
Exercises: Practice Midterm (completed by Friday at noon; solutions posted on Friday night)

10/22: IN-CLASS MIDTERM (Covering material from first half of course)

- 10/27: Introduction to Metatheory; Soundness and Completeness of PL through trees
Reading: Chapter 19 “PL trees vindicated” (in Smith’s *An Introduction to Formal Logic*, on D2L); [Rosiak, “Lecture Notes...”, pages 15-20]
Exercises: Questions in Sections 3 and 4 of my “Lecture Notes”
- 10/29: Metatheory continued; compactness; the “bigger picture” and some introduction to questions of *(un)decidability*
Reading: [Rosiak, “Notes”, pages 25-30]; Smullyan *Selection 2* on D2L
Exercise: Questions in Section 5 of “Lecture Notes”

Introducing Predicate Logic (Weeks 8-11)

- 11/03: Predicate Logic introduced: quantifiers; domain of discourse; variables, constants, predicates; scope; free vs. bound variables
Reading: [Hausman et al., , Chapter 7]
Exercises: 7-2, 7-4, 7-5, 7-10 in Hausman

- 11/05: Translations; validity, invalidity, and consistency
Reading: [Hausman et al., , Chapter 8]
Exercises: 8-2, 8-3, 8-4 in Hausman
- 11/10: Predicate Logic Proofs
Reading: [Hausman et al., , Chapter 9]; Copi *Selection 2* on D2L
Exercises: 9-1, 9-3, 9-5 in Hausman
- 11/12: More proof work; Relational Predicate Logic
Reading: [Hausman et al., , Chapter 10]
Exercises: 10-1, 10-3 (select just 5 of the odd problems), 10-4, 10-5 in Hausman
- 11/17: Finish Chapter 10 proof work; Theorem proving
Reading: [Hausman et al., , Chapter 10 continued]
Exercises: 10-8, 10-9, 10-11, 10-12 in Hausman
- 11/19: Rationale behind the Four Quantifier Rules
Reading: [Hausman et al., , Chapter 11 (focus on sections 1-3)]
Exercises: 11-1 in Hausman
- 11/24: The Bigger Picture; some limitations of first-order predicate logic; where to go after this
Reading: My “Where to go after learning basic logic?” handout on D2L
Exercises: Final Exam Review Sheet

Final Exam Monday 11/30 (covering material from second half of course)