Phil 0500: Introduction to Logic
14 weeks

Instructor

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Course Description

Critical thinking in any field requires the ability to assess *arguments*. In this course, students work on sharpening their formal reasoning skills. To that end, we will study the nature of good and bad arguments by analyzing the properties of an artificial language known as *first-order logic*. By the end of this course, you will:

(1) be familiar with basic concepts of logic,
(2) be able to translate statements from ordinary language into well-formed sentences of first-order logic and *vice versa*,
(3) be able to determine logical properties of arguments such as validity or soundness,
(4) be able to construct formal proofs in propositional logic, using a Fitch-style natural deduction system, and
(5) have acquired some familiarity with first-order predicate logic and be able to construct formal proofs that involve quantified expressions.

Prerequisites: none.

Required Textbook

The required text is *Language, Proof, and Logic*, 2nd edition, by Barker-Plummer, Barwise, and Etchemendy (hereafter: LPL). You can purchase the text at the university bookstore or online at http://www.gradegrinder.net/store.

Important Note:
Do **NOT** buy a used copy of LPL online. For this course, you'll need access to a fresh registration code that comes with each new copy of the textbook software. Used copies found online are likely to either not contain the CD with the software or not contain a fresh registration code. Likewise, if you get a used copy at the university bookstore, make sure you also get both a CD and a fresh registration code. If they cannot provide the latter, you need to buy a new copy. Having a copy of the book, being able to use the software, and to access the online resources is required for submitting homework and, thus, for taking the course.

Assessment

Your final grade will be determined as follows:

Homework: 30%
Midterm exam: 30%
Final exam: 30%
Short Quizzes: 10%

Assessment (continued):

General: You cannot succeed in this class while skipping the reading. To do well, you need to acquire a firm grasp of the concepts. This will be especially important in the first few classes, when we cover basic notions and go over the various logical connectives. If you don't stay on top of the material, you risk getting behind quickly. The more you prepare at home, the more class time can be devoted to practicing problem sets and to addressing specific questions you may have. Ideally, you also consult the ***extra material*** provided on the LPL website, including videos and further exercises.

Homework: Besides the assigned reading, there will be a number of ***homework assignments***. Note that late submissions are not accepted. All homework assignments must be submitted before the beginning of class on the day they are due (see schedule below). You must ***submit*** your homework in time. Some of the homework will be submitted via ***Blackboard***, most of it via ***the software*** that comes with the book: *Submit*. As you use *Submit*, you need to provide your instructor's name and his email address. Here they are:

Name: Raja Rosenhagen

Email: raja.rosenhagen@gmail.com

(The course is listed as [**INSERT COURSE NAME HERE]**.)

Midterm: There will be an in-class midterm exam on **[INSERT DATE]**.

Final Exam: There will be an in-class, cumulative final exam on **[INSERT DATE]**.

In-class Practice Problems: Occasionally, we may do ***practice problems*** in class. You can gain extra credit by volunteering to solve a problem on the blackboard – a problem you solve successfully counts like an A on a short quiz and the grade will be used instead of the grade you get on your weakest short quiz.

Late work: Late submissions are not accepted. If you don't submit a homework in time, you will receive an F (0%) for that assignment. Not submitting homework hurts your grade. Accordingly, it is imperative that you acquire the book before class starts and that you familiarize yourself with the software early enough to be able to a) work out potential technical issues and then b) use it to submit your first homework.

Extra Credit: Apart from the extra credit you can gain via solving in-class practice problems, you can submit extra work (typically further practice problems) via the software to make up for credit not gained from assigned problems. Extra problems will be announced each week separately.

Group work: Working with classmates in small groups to solve homework problems is an efficient way to practice and highly encouraged. Still, all work submitted must be your own (the software has ways to check this – copying homework is a violation of academic integrity). Also, the midterm and the final exam are in-class. If you simply copied your friends' work, you'd be in trouble when the time of the exams comes.

Website: I highly recommend you watch the ***video lectures*** from the textbook authors after reading over the relevant material in the book. The lectures can be found here: https://ggweb.gradegrinder.net/lpl/coursecontent

Schedule

PART I – Intro to FOL, system F (without Quantifiers)

Week 1

1st meeting:
What is Logic & why care; sketch of history of logic, including non-Western roots; informal introduction to quantifiers, various advanced branches of modern logic; deep philosophical questions about the status of logic and its principles; overview of what we will/won't do.

Readings: *LPL* Introduction; Chapter 1 (not: §§1.5-1.8)

2nd meeting:
Intro FOL – atomic sentences & their components: individual constants and predicate symbols; prefix vs. infix notation, arity; variables, sentences vs. open sentences; idealizations and conventions; intro block language & software Tarski's World

no new readings

Week 2

1st meeting: **Short Quiz 1, Homework 1 due**
Arguments: deductive, inductive, abductive arguments, valid, sound (conventions true/false, valid/sound, sentences/arguments); signal words in ordinary English; logical consequence; informal intro Fitch format

Readings: *LPL* Chapter 2

2nd meeting: **Short Quiz 2**
Intro notion of proof as a step-by-step procedure; informal vs. formal proofs; standards of rigor and certainty; intro natural deduction system *F*: method of justifying steps, first rules: identity introduction & elimination (reflexivity, symmetry, transitivity), reiteration, and Ana Con in Tarski's World; examples involving identity

no new readings

Week 3

1st meeting: **Homework 2 due**
intro Boolean Connectives: Negation, Conjunction, and Disjunction (truth-functional); ambiguity & parentheses; main connective, truth table method

Readings: *LPL* Chapter 3 (not: §§3.4 & 3.8); Chapter 4 (not: §§4.4-4.6)

2nd meeting: **Short Quiz 4**
concepts: conservativeness, TT-possible/ TW (Tarski's World)-possible, tautology & logical truth, TT-falsehood, tautological equivalence, tautological consequence, non-tautological logical equivalence, intro software Boole

no new readings

Week 4

1st meeting: **Homework 3 due**
Oddities: tautologies follow from everything & from contradictions, everything follows; motivate move from (unwieldy) truth tables to system *F*; 1st expansion of *F*: conjunction elimination & introduction, disjunction introduction (addition), negation elimination, & disjunction elimination (proof by cases) (1)

Readings: *LPL* Chapter 5; Chapter 6

Week 4 (continued)

2nd meeting: **Short Quiz 5**

Recap rules, proof by cases (2); 2nd expansion of *F*: intro contradiction introduction & elimination; negation introduction (proof by reductio); proof strategies, intro software Fitch

no new readings

Week 5

1st meeting: **Homework 4 due**

Recap proof by cases and proof by reductio; proof of tautologies from no premises; recap "truth-functional," truth-functional completeness; Sheffer stroke; example of non-truth-functional connective

Readings: *LPL* Chapter 7 (not: §§7.3 & 7.5); Chapter 8

2nd meeting: **Short Quiz 6**

Intro conditional and bi-conditional ("if, then," "only if," "unless," "iff," & "just in case"); necessary & sufficient conditions, binding rules; explain truth table of the conditional (false antecedent – conditional true) and show equivalence of "if A, B" and "not-A or B" and "not (A and not-B); mention different conditionals (esp. counterfactuals & example);

no new readings

Week 6

1st meeting: **Short Quiz 7**

Recap conditional & necessary and sufficient conditions, 3rd expansion of *F*: add conditional & biconditional introduction and elimination rules to *F*

no new readings

2nd meeting: **Homework 5 due, Short Quiz 8**

Practice problems, esp. identity, proofs w/o premises, subproofs (proof by cases, reductio, conditional intro)

no new readings

Week 7

1st meeting:

Concepts: soundness & completeness, review: concepts, proof strategies

no new readings

2nd meeting: **Homework 6 due**

IN-CLASS MIDTERM EXAM

no new readings

PART II – Reasoning with Quantifiers

Week 8

1st meeting:

Soundness of system *F*; atomic wffs; quantifiers symbols; free vs. bound variables; recap truth-functionality; explain how quantifiers are not truth-functional connectives

Readings: *LPL* Chapter 9 (not: §§9.7-8)

Week 8 (continued)

2nd meeting: **Short Quiz 9**

quantifier intro (2); semantics for quantifiers: satisfaction; definition of "sentence of FOL;" how to construct an interpretation (domain, predicates, constants)

no new readings

Week 9

1st meeting: **Short Quiz 10**; **Homework 6 due**

Aristotelian forms; translating complex noun phrases

no new readings

2nd meeting: **Short Quiz 11**

find tautologies/tautological consequences involving quantifiers: method of finding the truth-functional form

Readings: *LPL* Chapter 10 (not: §§10.5-6)

Week 10

1st meeting:

First-Order Validity, Consequence, and Equivalence; De Morgan's laws, Substitution of Equivalents; Negation and Quantifiers; Quantifiers & Conjunction/Disjunction; Null Quantification

no new readings

2nd meeting: **Short Quiz 12**

Multiple Quantifiers (same & mixed, order), intro step-by-step translation method

Reading: *LPL* Chapter 11 (not: §§11.6 & 11.8)

Week 11

1st meeting: **Homework 7 due**

Step-by-step (2), donkey sentences

no new readings

2nd meeting:

prenex form, more translation practice

no new readings

Week 12

1st meeting: **Homework 8 due**

Final expansion of system *F* (1): existential elimination & instantiation

Readings: *LPL* Chapter 12 (not: §§12.5) & Chapter 13

2nd meeting: **Short Quiz 13**

Final expansion of system *F* (2): universal instantiation and general conditional proof

no new readings

Week 13

1st meeting: **Homework 9 due**
strategy and tactics, practice problems

no new readings

2nd meeting: **Short Quiz 14**
practice problems translations & proofs

no new readings

Week 14

1st meeting: **Final Homework 10 due**
Final review: concepts, proof with quantifiers, practice

no new readings

2nd meeting:
IN-CLASS FINAL EXAM

Note that while the first half of the course is fairly settled, there is some leeway as to how fast we will proceed during the second half. We must of course ensure that we get a firm understanding of the concepts. But since the only way to significantly improve on constructing proofs and providing translations is practice, we will also engage in a lot of in-class practice exercises.

Course Policies

Academic Integrity

I expect you to comply with the University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy.

Disability Services

If you have a disability for which you are or may be requesting an accommodation, be sure to contact me, as well as Disability Resources and Services (DRS), 140 William Pitt Union, (412) 648-7890, drsrecep@pitt.edu, (412) 228-5347 for P3 ASL users. DRS will verify your disability and determine reasonable accommodations for this course.

Statement on Classroom Recording

To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion and/or activities without the advance written permission of the instructor, and any such recording properly approved in advance can be used solely for the student's own private use.

Statement on Course Materials

No course materials may be reproduced or posted online.