PHI1060/CS2160-2: SYMBOLIC LOGIC

Spring 2023
Times: TuTh 11:50-1:20 (AC01-205)

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COURSE DESCRIPTION

Suppose that all Germans like Sauerkraut. Then, you may use the fact that I am a German to infer that I like Sauerkraut. However, you should not use the fact that Sarah likes Sauerkraut to infer that Sarah is German. Formal logic studies cases like this and provides us with a notion of *deductive validity* that can explain why the first inference is better than the second. In this course, we will develop this notion, along with a few others, by studying two formal languages called "propositional logic" and "first-order logic". These languages will allow us to precisely define validity and to check whether a given argument is valid in these languages. Understanding these languages will also be helpful for analyzing spoken languages, and it gives us an insight into computer processing and programming languages as well.

LEARNING GOALS

As part of this course, you should acquire the following knowledge and skills:
- An understanding of the two formal languages we study, as well as proof systems for them, as well as the ability to apply these proof systems
- An understanding of semantics and the role of models in it, as seen from the two formal languages
- An understanding of the concept of deductive validity and the ability to contrast it with inductive and abductive reasoning
- An understanding of other notions such as logical necessity and possibility, contradiction, tautology and contingency
- An improvement to your ability to argue and analyze arguments
- A sensitivity to philosophical issues surrounding logic, including its foundations and the issues surrounding translations between formal and natural languages

STUDENT ASSESSMENT

Your grade for this course will be composed by the following components:
- One midterm exam (20%)
- A final exam (40%)
- Weekly homework sets (30%)
- Participation (10%)

The midterm exam will test you about all material covered until then. The final exam will be comprehensive, meaning that it will cover the entire course, but with a special emphasis on the materials covered after the midterm. Weekly homework will be assigned beginning in week 2, and will always be due on Monday, 9pm. (Homework submitted by Saturday will be graded before class on Tuesday, other homework may be graded later.) The participation grade will measure your attendance (see policies below) and how actively you have participated in lectures and DSs.

- Please aim to practice <u>respectful and constructive discourse</u> with your fellow students. Listen to what others have to say even if it does not relate to what you want to say. Do not interrupt others, and do not dismiss other perspectives. When you criticize others, make an effort to improve upon their ideas instead of flat-out rejecting them. Practicing this kind of discourse will make the class a much better experience for everyone, and may improve our capacity to engage with differing world views.
- It is important that we are able to start lecture and DS on time, and that everyone is present at the beginning. For that reason, <u>you are not allowed to participate in either if you are five minutes or more late</u>. If this happens, you will be sent away from lecture/DS. You will also not be counted as having attended that session.
- <u>Attendance</u> is mandatory for both the lecture and the discussion sections. You can miss up to four classes total (counting both together, e.g. three lectures and one DS) without an excuse, any further absence requires a valid excuse (e.g. illness documented by a doctor's note). More than four unexcused absences will result in a penalty on your participation grade.
- You are <u>not allowed to use electronics</u> in lecture and DS, including laptops, tablets and phones. A broad range of studies show that the use of electronics in classroom settings leads to diminished learning outcomes. Exceptions are made for students with relevant accommodations from the OLS.
- <u>Homework submission policy</u>: all homework is due at 9pm on the posted due date. There is a grace period until 1am, during which papers are considered to be submitted on time. After that, every day the homework is late will reduce its grade by 10% (so a 90% on your homework will become 80% for one day, 70% for two days, etc.).
- The lowest homework score will be <u>dropped</u> from your homework average. This includes <u>unsubmitted homework, which will be graded 0</u>.If you have more than one unsubmitted homework, it will impact your grade accordingly.
- <u>Extensions</u> can be granted only in cases in which you are impacted by unforeseeable events like illness, and they must be agreed on before the deadline for the homework. Please include documentation like a doctor's note when asking for an extension.
- <u>Academic integrity</u> is important, and I will severely penalize any violation even at the first instance. Such violations include submitting homework that is not entirely your own work, using any kind of help during the exams (including copying from others, using electronics or bringing "cheat sheets") and any kind of deception about your work or other aspects of your course participation.
- If you need an <u>accommodation</u> for this class, please contact the Office of Learning Support or make sure they forward me your accommodation. I will confirm receipt of their email when I get it and make suggestions/discuss how to best implement those accommodations.
- This course will use a grading rubric where anything above 90% is an A, anything above 85% is an A-, anything above 80% s a B+ etc.

EXTRA CREDIT
There are two ways of earning extra credit for this course:
- <u>Find a mistake</u> on the course materials. I am writing logic slides for the first time, and I expect that I will make many mistakes. The first student to spot a given mistake on the slides or on the homework assignments can earn extra credit by sending me an email pointing out that mistake (it must be pointed out specifically). Only the first person sending such an email will get credit, and I will make a list of spotted mistakes available.
  The following things do <u>not</u> earn you extra credit:
  ○ Simple typos such as "predictate" instead of "predicate"

- ○ Grammatical mistakes
- ○ Poor choice of expression

However, the following <u>do</u> earn you extra credit:
- ○ Any kind of mistake within a formula (including missing parentheses etc.)
- ○ Any mistake in the content on the slides
- ○ Cases of unnecessarily complicated definitions or proofs (unless they are chosen deliberately)

Every genuine mistake spotted will give you a 10 point bonus on your participation grade. If the mistake is particularly difficult to spot, the bonus may be higher.

- In addition, you can earn extra credit by completing <u>extra credit problems</u> which will sometimes be included in the homework sets. These problems will raise your score on the given homework set directly. They will often either be far more complicated than the rest of the homework or require you to think about philosophical aspects in some depth, so I only recommend completing them if you have time to spare.

SOME GENERAL ADVICE

- Logic can be <u>scary</u> at first, especially if you are not used to working with formal methods – it may feel like math to you, and didn't you want to study philosophy so you can avoid math? However, don't let yourself be frightened by that. Everyone can learn logic if they approach it calmly and take time with it. Logic also does not require any knowledge of math as a prerequisite for understanding it. If you are confused by any aspect of the course, please do raise this with us, we will go back or go more slowly on the material.
- Logic <u>takes time and practice</u>. Don't expect that you will be able to master a proof system the moment you hear about it. A big part of the course is trying to figure out how things work by practicing them. You cannot passively listen to the lecture and read the slides, you need to actively try out things to learn them. As a result, do not delay your homework until the last minute – it may take more time than you expected, and often it helps to go back to it the next day.
- The contents of the course <u>build on each other</u>. This means that if you miss out on content in the earlier portions of the course, you will struggle to understand the later portions. Make sure that you keep on top of the materials by devoting enough time to the homework.
- A <u>study group</u> is a great idea for logic. While you do have to do your homework by yourself, it can be very helpful to just sit together and do a few practice problems. Your classmates will often be able to explain techniques to you, and you will benefit from explaining things to others by deepening your understanding and noticing problems you still have.
- If you have questions or are experiencing any type of difficulties, do <u>send us an email</u>. If you are struggling with writing an email to your professor/TF, this guide might be helpful to you: https://www.wikihow.com/Email-a-Professor
- DON'T PANIC

COURSE SCHEDULE

Day	Topic	Notes
January 24	Introduction	
January 26	*Republic Day – no class*	No homework this week
January 31	Argumentation theory / Induction vs. Deduction	
February 2	Reconstructing arguments	First homework assigned

February 7	(Naive) Set Theory	
February 9	Syntax Propositional Logic	
February 14	Semantics Propositional Logic	
February 16	Truth Tables	
February 21	Natural Deductions	
February 23	Natural Deductions cont'd	
February 28	Translations	
March 2	Translations cont'd	
Spring Break		
March 14	Some features of propositional logic	
March 16	Review session	No homework this week
March 21	Midterm exam	
March 23	Syntax Predicate Logic	
March 28	Semantics Predicate Logic	
March 30	Semantics Predicate Logic cont'd	
April 4	Natural Deductions in Predicate Logic	
April 6	Natural Deductions cont'd	
April 11	Translations	
April 13	Translations cont'd	
April 18	Identity as an extension of Predicate Logic	
April 20	Identity cont'd	
April 25	Some outlooks: multi-valued logic	Not exam-relevant
April 27	Course review	No homework this week
May 8	Final exam	11:30-1:30, AC01-205

READINGS/COURSE MATERIALS

There are no compulsory readings for this course. Relevant definitions etc. will always be included on the slides, which will be made available through the Google Drive folder for this class, available through Google Classrooms.

However, the course will be formally consistent with the following book:

Volker Halbach. *The Logic Manual*. Oxford University Press 2010.

You won't need to buy this book, but you may find the materials that Halbach has posted on his website useful: https://users.ox.ac.uk/~logicman/