PHIL 210: Introduction to Deductive Logic

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Class Location: RPHYS 118 (In-person lectures)
Class Time: Mon-Thurs, 11:05am-13:25pm
Office Hours: Fri 1-3pm, zoom link to be shared on Mycourses

Course Description:

The primary goal of this course is to provide a general introduction to deductive logic. Deductive logic is the study of patterns of ***valid arguments***; a valid argument is an argument where the conclusion is a logical consequence of the premises. To study these patterns, we will be concerned only with formal features of inference and abstract away from information without logical import. In this course we will be focusing on two artificial languages in particular: *truth-functional logic* (TFL) and *first-order logic* (FOL).

In the first half of the course, we will introduce *truth-functional logic* (TFL), also known as *sentential logic* or *propositional logic*. The basic idea of TFL is that (atomic) sentences can be connected, with logical connectives, to form more complex sentences. TFL is so-called because in TFL the truth or falsity of a complex sentence is fully determined by the truth or falsity of its component parts. We will systematically assign truth values (true/false) to sentences and use truth tables to determine whether a sentence is logically equivalent to or follows semantically from others; we will also produce counterexamples to show that an argument is invalid. Finally, we will learn a proof system for TFL, consisting of syntactic inference rules to derive logical consequences.

In the second half of the course, we will introduce *first-order logic* (FOL), also known as *predicate logic*. To do so we will introduce names, variables, predicates, and quantifiers into our logical vocabulary. This extended vocabulary allows us to express what we could not in TFL, for instance, ‘there are exactly three Bengal cats’, but it also makes the language too complex for truth-tables. We will thus need to introduce the notions of *domain* and *interpretation* for the production of counterexamples. Syntactically, we will also update our proof system to accommodate FOL. We will end by introducing two important results for FOL, namely, that it is both *sound* and *complete*, although we will not prove these results.

Course Format

All summer 2022 courses at McGill are offered in-person, and PHIL 210 is no exception. Course lectures will not be recorded, but all lecture slides will be posted on Mycourses.

Student Learning Outcomes:

By the end of this course, you should be able to:

- Translate natural language sentences into the languages of TFL or FOL
- Understand basic semantic concepts such as validity, entailment, and logical equivalence and know when to apply them
- Construct and interpret truth-tables to evaluate sentences and arguments in TFL
- Construct proofs in a natural deduction system (Fitch) for TFL and FOL
- Construct *interpretations* to produce counterexamples to FOL arguments, showing that a particular argument is invalid
- Understand basic metatheoretic results, namely, soundness and completeness theorems for TFL and FOL

Friendly Warning:

Many students will find the second half of the course substantially more challenging than the first. The second half will build on what we will have learned in the first half, which makes the course material inherently cumulative. There is no shortcut to mastering logic; the best way to become proficient at using any language, artificial or otherwise, is by using it.

Course material:

1. The only textbook we will use for this course is the open-source textbook *Forall x: Calgary*. It is available for download here: https://forallx.openlogicproject.org/ as well as on mycourses.

   We will not discuss all chapters of the textbook and some additional materials will be covered in lectures. The textbook is nevertheless an essential part of the course material. You should aim to do all exercises provided in the textbook.

2. For both Exercises and Assignments, we will make use of the following open-source online system: http://carnap.io. To be able to use this, you have to register with it with a Google address, for example a gmail address. Once registered, you will then be able to choose 'McGill - PHIL 210 Introduction to Deductive Logic (Summer 2022)' in the dropdown menu. As the course progresses, more and more items will appear under "Assignments", and it will be clear from the title whether it's for practice or a graded assignment.

   You can use the following registration link: https://carnap.io/enroll/McGill%20-%20PHIL%20210%20Introduction%20to%20Deductive%20Logic%20%28Summer%202022%29

   The carnap interface is very easy to use. It accepts ordinary keystrokes instead of special symbols and will produce for you the special symbols (e. g., for the special symbol '∧' which we use, carnap will accept any of '&', 'and' and more, but will display '∧' back to you in its output. Similarly, for the symbol '∀x', it will accept ordinary things like 'Ax' or 'All x').

Class Schedule:

Week 1: Key Notions of Deductive Logic; Truth-Functional Languages (TFL); Truth Tables.
(Part I-III of Forall x: Calgary)

Assignment 1: Released Friday May 6th 17h EDT – Due Monday May 9th 23h59 EDT.

Week 2: Fitch Proof System for TFL.
(Part IV of Forall x: Calgary)

Assignment 2: Released Friday May 13th 17h EDT – Due Monday May 16th 23h59 EDT.

Week 3: Extending Key Notions to First-Order Languages (FOL).
(Part V and VI of Forall x: Calgary)

Assignment 3: Released Friday May 20st 17h EDT – Due Monday May 23th 23h59 EDT.

Week 4: Fitch Proof System for FOL; Review of Soundness and Completeness results for FOL.
(Part VII of Forall x: Calgary and lecture/handout)

Assignment 4: Released Friday May 27th 17h EDT – Due Monday May 30st 23h59 EDT.

Grading and Evaluation:

There will be four (4) weekly assignments, each worth 25% of your final grade. Assignments will be released each Friday at 17h EDT, and due the following Monday at 23h59 EDT. These will be timed online assessments, completed on Carnap.io. Each assignment is designed to be completed within one and a half hours, but you will be given 3 hours to do so. Completion of all assignments is mandatory.

Each week you will also have the opportunity to get 3-4 bonus points (at least 12% of your final grade) by answering two or three theoretical questions in short essay format, which you must upload as a PDF document to MyCourses (same due date, the title of the document must be "YourLastName, Assignment X", where 'X' is the number associated with the assignment).

Assignment Late Policy:

Extensions will be granted only in exceptional circumstances (illness, death of a family member, political instability, major power outages, etc). Late work without a granted extension will be penalized at the rate of a full letter grade (12.5%) per day overdue. Should you need an extension, please notify me as soon as possible.

McGill University Policies:

1. *McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures. (See www. mcgill.ca/integrity for more information).*

2. *In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.*

3. *In accord with McGill University's Charter of Students' Rights, students in this course have the right, without seeking permission, to submit in English or in French any written work that is to be graded.*

4. *As instructors of this course, the Lecturer and TAs endeavor to provide an inclusive learning environment. If you experience barriers to learning in this course, do not hesitate to discuss them with us or with Student Affairs, or with the Office for Students with Disabilities, https: // www. mcgill.ca/osd , tel.: 514-398-6009.*

5. *McGill University is on land which is the traditional and unceded territory of the Kanien'keha:ka (Mohawk), a place which has long served as a site of meeting and exchange amongst nations.*