Modal Logic and Its Applications

Johns Hopkins University, Spring 2017

Course Information

Instructor	Justin Bledin
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Office Hours	F 2:00pm-3:00pm & by appt
Class Code	AS.150.498
Class Time	TTh 1:30pm-2:45pm
Class Location	Gilman 75

Course Description

In the first part of the course, we investigate the theory of propositional modal logic, considering its syntax, semantics, proof theory, and relation to first-order logic. In the second part, we turn to some applications of modal logic in philosophy and mathematics including: temporal logic, counterfactuals, deontic logic, epistemic logic, intuitionistic logic, and provability logic. In the third part of the course, we consider quantified modal logic.

Prerequisites

A solid understanding of classical first-order logic is essential. Students should also be familiar with basic methods of mathematical proof.

Schedule

The following schedule projects the lectures over the course of the semester. It is subject to revision as the semester progresses. Especially in the second applications component of the course, I want to keep things fairly flexible and allocate our time based on which topics you find the most interesting.

1. Propositional Modal Logic

1.1 Introduction	Jan 31
1.2 Language	Jan 31
1.3 Semantics	Jan 31, Feb 2
1.4 Equivalence and Expressivity	Feb 2, Feb 7
1.5 Decidability	Feb 7, Feb 9
1.6 Completeness	Feb 14, Feb 16
1.7 Normal Modal Logics and Correspondence Theory	Feb 16, Feb 21
1.8 Non-Normal Modal Logics	Feb 23

2. Applications & Connections

2.1 Temporal Logic	Feb 28, Mar 2
2.2 Counterfactuals	Mar 7, Mar 9
2.3 Deontic Logic	Mar 14, Mar 16
2.4 Static Epistemic Logic	Mar 28, Mar 30
2.5 Dynamic Epistemic Logic	Apr 4, Apr 6
2.6 Intuitionistic Logic	Apr 11, Apr 13
2.7 Provability Logic	Apr 18

3. Quantified Modal Logic

3.1 Language	Apr 20
3.2 Semantics	Apr 20, Apr 25
3.3 Miscellaneous Topics	Apr 27, May 2
Review	May 4

Readings

I will be teaching from my own notes that draw heavily on a similar course taught by Wesley Holliday at UC Berkeley in Fall 2012. Unfortunately, Wes has yet to write his modal logic bible. So there is no official textbook for this course.

If you want to supplement my notes with additional readings, here are some suggestions.

General:

- Brian Chellas. *Modal Logic: An Introduction*. Cambridge University Press, Cambridge, 1980.
- Johan van Benthem. *Modal Logic for Open Minds*. CSLI Publications, Stanford, 2010.

(Note that the Chellas text is a bit outdated and the van Benthem text is good for students who already know a bit of modal logic.)

Theory of Propositional Modal Logic:

- Eric Pacuit. Notes on Modal Logic. Unpublished, available at `http://web.pacuit.org/`.

Temporal Logic:

- Yde Venema. Temporal Logic. In Lou Goble, editor, *The Blackwell Guide to Philosophical Logic*, pages 203–223. Blackwell, 2001.

Counterfactuals:

- David Lewis. *Counterfactuals*. Blackwell, 1973.

Deontic Logic:

- Risto Hilpinen. Deontic Logic. In Lou Goble, editor, *The Blackwell Guide to Philosophical Logic*, pages 159–182. Blackwell, 2001.

- Niko Kolodny and John MacFarlane. Ifs and oughts. *Journal of Philosophy*, CVII(3):115–143, 2010.

Epistemic Logic:

- Wesley Holliday. Epistemic Logic and Epistemology. In Sven Ove Hansson and Vincent Hendricks, editors, *Handbook of Formal Philosophy*. Springer, forthcoming.
- Seth Yalcin. Epistemic Modals. *Mind*, 116(464):983–1026, 2007.

Intuitionistic Logic:

- Graham Priest. *An Introduction to Non-Classical Logic: Second Edition*. Cambridge University Press, Cambridge, 2008.
- Dirk van Dalen. Intuitionistic Logic. In Lou Goble, editor, *The Blackwell Guide to Philosophical Logic*, pages 224–257. Blackwell, 2001.

Provability Logic:

- George Boolos, John Burgess, and Richard Jeffrey. *Computability and Logic: Fifth Edition*. Cambridge University Press, Cambridge, 2007.
- George Boolos. Gödel's Second Incompleteness Theorem Explained in Words of One Syllable. *Mind*, 103(409):1–3, 1994.

Quantified Modal Logic:

- Melvin Fitting and Richard Mendelsohn. *First-Order Modal Logic*. Kluwer, Dordrecht, 1998.

The *Stanford Encyclopedia of Philosophy* is also an invaluable starting point for further research in these areas.

Requirements

There are three requirements for taking this course.

The first requirement is to complete a series of exercise sets throughout the semester. These exercise sets will be assigned roughly every two weeks and you will have one week to complete them. The sets are worth 40% of your final grade.

The second requirement is to write a less than 10 page double-spaced final paper on a topic of your choice. This paper is due on May 11 and is worth 25% of your final grade.

The third requirement is to take a final in-class exam on May 18 between 2-5pm. This is worth 35% of your final grade.

In lieu of satisfying these requirements, graduate students not taking this course to fulfill the logic requirement can submit a less than 20 page double-spaced paper on a course-related topic of their choice on May 18.

Since your primary source of information is my lectures, attendance is strongly encouraged.

Academic Integrity

Please do not cheat. This would be depressing. Cheating hurts the Johns Hopkins community by undermining academic integrity, creating mistrust, and fostering unfair competition. Students caught cheating may receive an F in the course and can face direr consequences in extreme cases.

You can find more information here:

`http://e-catalog.jhu.edu/undergrad-students/student-life-policies/#UAEB`.

Disability Accommodations

If you are a student with a disability or believe that you might have a disability that requires special accommodations, please contact Student Disability Services to obtain a letter from a specialist: `studentdisabilityservices@jhu.edu`. Then pass on the letter to me.

Enjoy the course!