Modal Logic

Online PHIL 3340/MATH 3850

Description

Modal logic is a general logical framework for systematizing reasoning about qualified and relativized truth. It has been used to study the logic of possibility, time, knowledge, obligation, existence, and much more. This course will explore both the theoretical foundations and the various philosophical applications of modal logic. On the theoretical side, we will cover basic metatheory, including Kripke semantics, soundness and completeness, correspondence theory, and expressive power. On the applied side, we will examine temporal logic, epistemic logic, deontic logic, counterfactuals, two-dimensional logics, and quantified modal logic.

Prerequisites: an introductory course on deductive logic (PHIL 2310 or equivalent)

Instructor

Instructor: Arc Kocurek
Email: awk78@cornell.edu

Office Hours: W 9:55–11:10am (or by appointment)

Readings

Required: Johan van Benthem, *Modal Logic for Open Minds*. All other required readings will be made available on Canvas.

Optional texts

- Velleman, *How to Prove It* (general introduction to proofs)
- Chellas, *Modal Logic: An Introduction* (a classic; excellent introduction)
- Sider, *Logic for Philosophy* (great text for beginners; second half covers modal logic)
- Priest, *An Introduction to Non-Classical Logic* (has several accessible chapters on modal logic)
- Hughes and Cresswell, *A New Introduction to Modal Logic* ("new" in 1996. . . but still good; intermediate, not for beginners; old notation)
- Blackburn, de Rijke, and Venema, *Modal Logic* (advanced; graduate-level; the bible of modal logic; also known as "the Dutch book")

Lectures

Lectures will be prerecorded and posted on Canvas. The second of the two lecture times (W 9:55–11:10am) will be used as an open Q&A to discuss the material and the problem set. (If there's enough demand, I will do the same for the M 9:55–11:10am lecture as well.) If you need additional assistance, feel free to schedule a separate appointment with me on a case-by-case basis.

Grades

Problem Sets	50%	11 in total (lowest problem set grade dropped)
Midterm Problem Set	15%	take-home
Research Paper	35%	2000–2500 words

Assignments

Problem Sets

There are weekly problem sets (11 in total, 1 drop). These generally cover the material from the previous week's lectures.

- Each problem set is worth 5% of your total grade.
- Problem sets are due on **Friday at 9am**. No late problem sets will be accepted, as the solutions will be posted online shortly afterwards.
- Your lowest problem set grade will be dropped.
- All problems sets must be uploaded as a PDF to Canvas. They can be either handwritten or typed in LaTeX (*please* do not use Word!).
- You are permitted (indeed, encouraged!) to work in groups on problem sets, so long as (1) your solutions are your own work and not the result of just copying others' work, and (2) you write the names of those you worked with on the problem set.

Midterm Problem Set

There is a take-home midterm. It is basically a longer problem set on the material from the Theory unit. It is due by **October 23rd at 9am**. You are permitted to work in groups under the same conditions as for problem sets.

Final Paper

There will be a final paper where you are asked to apply modal logic to a philosophical problem. For undergraduates, it will be between 2200–2500 words (≈7–8 pages with 1.5 line spacing). For graduates, it will be between 3000–5000 words (≈10–15 pages). The paper is due by **December 21st at 9am**. More details will be provided as we get closer to the due date.

Policies

Academic Integrity

We strictly adhere to the University Policy on Academic Integrity, as outlined in the Code of Academic Integrity (http://cuinfo.cornell.edu/aic.cfm). It is your responsibility to familiarize yourself with the Code and what constitutes a violation of it. All work submitted must be the student's own, and all sources must be properly cited. Any violation of this policy will be reported immediately. Violations will, at the very least, result in an F on the assignment, but may also to lead to an F in the class, suspension, or even expulsion.

Schedule

van Benthem 2010 = *Modal Logic for Open Minds*

Theory

Week 1

09/02 **What is Modal Logic?**
Reading: van Benthem 2010, ch. 1 (optional); Fitting and Mendelsohn 1998, ch. 1.1–1.5 (optional); Blackburn et al. 2001, ch. 1.7 (optional)

Week 2

09/07 **Sets**
Reading: Partee et al. 1990, ch. 1

09/09 **Relations**
Reading: Partee et al. 1990, ch. 2.1–2.2 and ch. 3 (ch. 2.3–2.4 recommended)

09/11 **PS1 DUE**

Week 3

09/14 **What is a Logic?**
Reading: none

09/16 **Kripke Semantics**
Reading: Pacuit 2009, § 1; van Benthem 2010, ch. 2.1–2.2; Fitting and Mendelsohn 1998, ch. 1.6–1.7 (optional)

09/18 **PS2 DUE**

Week 4

09/21 **Validity and Consequence**
Reading: Pacuit 2009, § 2; van Benthem 2010, ch. 2.3; Fitting and Mendelsohn 1998, ch. 1.8–1.9 (optional)

09/23 **Decidability**
Reading: van Benthem 2010, ch. 4.1, 4.4

09/25 **PS3 DUE**

Week 5

09/28 **Modal Equivalence**
Reading: Pacuit 2009, § 3 (up to Definition 3.3); Blackburn et al. 2001, pp. 51–57

09/30 **Bisimulation**
Reading: Pacuit 2009, § 3 (pp. 8–10); van Benthem 2010, ch. 3.1–3.4 (ch. 3.5 optional); Blackburn et al. 2001, ch. 2.2 (optional, advanced)

10/02 **PS4 DUE**

Week 6

10/05 **Axiomatic Proofs**
Reading: van Benthem 2010, ch. 5.1–5.6; Blackburn et al. 2001, ch. 1.6

10/07 **Soundness and Completeness**
Reading: van Benthem 2010, ch. 5.7–5.8; Blackburn et al. 2001, ch. 4.2 (optional, advanced)

10/09 **PS5 DUE**

Week 7

10/12 **The Landscape of Modal Logics**
Reading: van Benthem 2010, ch. 8.1–8.2

10/14 **Correspondence Theory**
Reading: van Benthem 2010, ch. 7.1–7.2, 9.1–9.3

10/16 **PS6 DUE**

Applications

Week 8

10/19 **Temporal Logic I**
Reading: Fitting and Mendelsohn 1998, ch. 1.10; Venema 2001, § 1–3 (up to Theorem 3.1); van Benthem 2010, ch. 18.1–18.3 (optional)

10/21 **Temporal Logic II: Future Contingents and the Master Argument**
Reading: Fitting and Mendelsohn 1998, pp. 35–40; Venema 2001, § 4; van Benthem 2010, ch. 18.5 (optional)

10/23 **MIDTERM PROBLEM SET DUE**

Week 9

10/26 **Counterfactuals I**
Reading: Lewis 1973, ch. 1.1–1.4, ch. 2.3; van Benthem 2010, ch. 13.4 (optional)

10/28 **Counterfactuals II: Counterfactual Reasoning**
Reading: Lewis 1973, ch. 1.5–1.8, ch. 3.4

10/30 **PS7 DUE**

Week 10

11/02 **Deontic Logic I**
Reading: Hilpinen 2001, § 8.1–8.4; van Benthem 2010, ch. 16.1–16.3

11/04	**Deontic Logic II: Conditional Obligations** *Reading:* Chisholm 1963; Hilpinen 2001, § 8.5; Lewis 1973, ch. 5.1
11/06	**PS8 DUE**

Week 11

11/09	**Epistemic Logic I** *Reading:* Fitting and Mendelsohn 1998, ch. 1.11; Holliday 2016a; van Benthem 2010, ch. 12.1–12.3 (ch. 13.1–13.3 optional); Stalnaker 2006 (optional)
11/11	**Epistemic Logic II: The Surprise Exam Paradox** *Reading:* Sorensen 1988, pp. 253–255, 289–292, 317–320; Holliday 2016b (optional)
11/13	**PS9 DUE**

Week 12–13: Semi-Finals and Thanksgiving

Week 14

11/30	**Quantified Modal Logic I** *Reading:* Fitting and Mendelsohn 1998, ch. 4.1–4.3, 4.5–4.7
12/02	**Quantified Modal Logic II: The Paradox of Nonbeing** *Reading:* van Benthem 2010, ch. 11.1–11.3; Fitting and Mendelsohn 1998, ch. 4.9, ch. 8.1, 8.3–8.8
12/04	**PS10 DUE**

Week 15

12/07	**Quantified Modal Logic III: Frege's Puzzle** *Reading:* Kripke 1971; Lewis 1968 (optional); Aloni 2005 (optional)
12/09	**Higher-Order Quantification** *Reading:* Fine 1970; Kaplan 1995; Williamson 2013, ch. 1 (optional)
12/11	**PS11 DUE**

Week 16

12/14	**Intuitionistic Logic** *Reading:* Priest 2008, ch. 6.1–6.3, 6.5–6.6, 6.8; van Benthem 2010, ch. 20.1–20.4 (optional)
12/16	**Two-Dimensional Logic** *Reading:* Davies and Humberstone 1980, § 1–2 (§ 3–4 optional); Evans 1979 (optional)

Week 17

12/21	**FINAL PAPER DUE**

References

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