PHIL 451: Higher-order Logic

Time and place

Tuesdays and Thursdays 9:30-10:50. DMC 203

Contact

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Textbook

A Philosophical Introduction to Higher-order Logics. Andrew Bacon. Routledge.

Links

dropbox | signup sheet | guidelines for writing a paper proposal |

Course description

Higher-order languages expand the language of first-order logic by allowing generalizations into grammatical positions other than that of singular terms. They have found numerous applications in philosophy, computer science, mathematics and linguistics. This course introduces students to higher-order languages, their proof and model theory, and their applications.

Objectives: In this course students will learn to be proficient with the λ notation; to formulate ideas in higher-order languages and to reason from them; how to build theories stated in higher-order languages and to use models to probe their consequences; about the philosophical applications of higher-order languages.

Prerequisites

PHIL 350, PHIL 222. The prerequisites may be waived if the student can demonstrate some relevant background, which may include relevant courses in mathematics, linguistics or computer science.

Grading

- Participation: 20%
    - Contribute to class discussion. Be prepared to answer questions if called upon, and to raise your hand if you do not understand something. You are collectively responsible for setting the pace of the class, and clarificatory questions. 5%

– Every week, three students will present a solution to an exercise of their choice on the board. The signup sheet for these presentations can be found here. Once you have signed up for an exercise please do not sign up again until we have made a full cycle of the class. 15%.

- Exercises 50%

  – Weekly exercises will be graded on a pass fail basis, and must be submitted by Tuesdays 9:30, before we discuss them in class.

    A pass does not necessarily mean your answer is correct: it means that you have engaged seriously with the question, and that you can explain your strategy and any difficulties you encountered. Correct answers will be discussed in class.

  – Exercises must be uploaded to blackboard. Submissions normally consist of photos of handwritten solutions; LaTeX or other software for typesetting logical symbols can be used but is not necessary.

  – Grades will be released before the following exercises are due.

  – If you can provide a reason that you will not complete the exercises by the deadline, let me know *in advance*, and we can discuss an extension.

- Final Project: 5% + 25%

  – Proposal: 5%. Due April 9.

    Submit a detailed proposal of what you intend to do your final project on.

  – Final project: 25%. Due April 30th. (Grades released: May 7th).

Schedule

- **Week 1**. Typed and higher-order languages: what are they, and why are they useful?

  – Informal introduction to types, first and higher-order generalizations, and surrounding philosophical issues.
  – Reading: Chapter 0

- **Week 2**. Types and typed languages.

  – Types, typed languages, the "concept horse" problem.
  – Reading: Chapter 1.

- **Week 3**. An informal introduction to abstraction.

  – Definitions by abstraction, λ-notation, Currying.

- **Weeks 4, 5**. λ-languages.

- – λ-languages, combinators, α, β, and η-equivalence, translations between λ-languages and combinatory languages.
  - – Reading: Chapter 3.

- **Weeks 6, 7**. Higher-order languages and higher-order logics.

  - – Higher-order languages, reasoning in higher-order theories and logics, inductive definitions in higher-order languages.
  - – Reading: Chapters 4 and 5.

- **Week 8**. Higher-order theories of granularity.

  - – Extensionalism, the Boolean theory of propositional individuation, weakenings thereof and philosophical motivations.
  - – Reading: Chapter 6.

- **Weeks 9, 10**. Modal logic.

  - – Higher-order logic and its relation to modal logic, discussion of topics in the philosophy of modality.
  - – Reading: Chapter 7 and 8. Selection from Williamson *Modal Logic as Metaphysics*.

- **Week 11**. General λ-languages.

  - – General λ-languages and motivations for studying them, Curry typing.
  - – Reading: Chapter 9 and 10.

- **Weeks 12, 13**. Applications for propositional structure.

  - – Philosophical applications to structured theories, the Russell-Myhill paradox, converse relations.
  - – Reading: Chapters 11-13.

- **Week 14**. Applicative structures.

  - – Applicative structures, functional and non-functional structures, the environment model condition.
  - – Reading: Chapter 14, sections 1-3

- **Week 15**. Models.

  - – Models of H, soundness and completeness, philosophical issues surrounding incompleteness.
  - – Reading: Chapter 15.

- **If there's time**. Advanced model theory.

  - – Logical relations, categories.
  - – Reading: Chapters 16-18.

Classroom norms

Please come to class ready to learn, and prepared to engage in class discussions. Clarificatory questions are always appreciated, and can be helpful to your classmates. Be constructive in your interactions with other students, and try when possible to help each other out.

Laptops, phones and other distractions must be out of sight during class. I encourage students to take handwritten notes; if you have a special reason to use an electronic device contact me about it.

Statement on academic conduct and support services

Academic Conduct

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the USC Student Handbook. All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Support Systems

Counseling and Mental Health - (213) 740-9355 - 24/7 https://studenthealth.usc.edu/counseling Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide & Crisis Lifeline - 988 or 1 (800) 273-8255 - 24/7 on call https://988lifeline.org Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press "0" after hours - 24/7 on call https://studenthealth.usc.edu/sexual-assault Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) - (213) 740-5086 | Title IX - (213) 821-8298 https://equity.usc.edu, https://titleix.usc.edu Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298 https://usc-advocate.symplicity.com/care_report Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response.

Office of Student Accessibility Services (OSAS) - (213) 740-0776 (previously called Disability Services and Programs (DSP)) https://osas.usc.edu Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Campus Support and Intervention - (213) 821-4710 https://campussupport.usc.edu Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101 https://diversity.usc.edu Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 - 24/7 on call https://dps.usc.edu, https://emergency.usc.edu Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 - 24/7 on call https://dps.usc.edu Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC) https://ombuds.usc.edu A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.