CS 578 Programming Language Semantics – Spring 2024

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Description

This course provides an introduction to the mathematics of program meaning (semantics) using the framework of type systems and typed languages. Topics include operational and denotational semantics; inductive proof techniques; the lambda-calculus and its extensions; simple imperative languages; basic and advanced type systems; type safety and other meta-theoretic properties.

Prerequisites

In spirit, this is primarily a math course. The theoretical material in the course is self-contained, so there are no specific prerequisites, but a reasonable level of mathematical maturity is assumed. For example, you should be comfortable with proofs by induction, simple set theory, and elementary logic, to the level of a rigorous undergraduate discrete math course.

You should also be familiary with basic concepts from the study of programming languages, such as grammars, abstract syntax, evaluation, and compilation, to the level of CS558.

Programming exercises will be in the OCaml language. Previous exposure to a functional language such as Scala (to the level of CS558) or Haskell (as in CS557) is assumed.

Readings

We will use the textbook "Types and Programming Languages," by Benjamin C. Pierce, MIT Press, 2002. Additional readings, made available on the course web page, will be assigned from time to time.

Requirements

There will be weekly homework assignments, a midterm, and a week-long take-home final exercise. The midterm will be in-class, closed-book. The homework assignments will include both theory problems and short OCaml programming exercises. Only selected problems will be graded in detail, but you should attempt them all as preperation for the exams and final exercise. Note that answers are provided to many assignment questions in the back of the book, but merely copying these answers will teach you nothing.

Homework may be submitted on paper (in class) or via email as a .pdf file. You are strongly encouraged, although not required, to typeset your homework using the latex system.

The course grade will be distributed as follows:

Homework	40%
Midterm	30%
Final Exercise	30%

Although it will not be formally assessed, class participation is strongly encouraged, and may affect borderline grades.

Computing Facilities

Some of the homework exercises will require use of the OCaml language; any recent version will do. It is installed on the CS department linux systems. It is also very easy to install on your own personal machine (and doesn't require many resources).

Latex is also available on the department linux systems, online using Overleaf, or can be installed on your own machine (easy, but has a large footprint).

Individual Work

It is permitted (even encouraged) for you to work together on homework assignments. However, all homework submissions must be written up individually; an important part of the course is learning how to write down theoretical arguments, even after they are clear in your own mind.

The midterm and final exercise must be completed individually without any collaboration. Cheating on either of these will result in an automatic zero grade and the initiation of disciplinary action at the University level.

Title IX Reporting Obligations

Portland State is committed to fostering a safe, productive learning environment. Title IX and our school policy prohibit gender or sex-based discrimination and sexual misconduct (including harassment, domestic and dating violence, sexual assault, and stalking). We expect a culture of professionalism and mutual respect in our department and class. You may report any incident of discrimination or discriminatory harassment, including sexual harassment, to either the Office of Equity and Compliance (https://www.pdx.edu/diversity/equity-compliance) or the Office of the Dean of Student Life (https://www.pdx.edu/student-life/dean-of-student-life).

Please be aware that members of the faculty have the responsibility to report any instances of sexual harassment, sexual violence and/or other forms of prohibited discrimination to PSU's Title IX Coordinator, the Office of Equity and Compliance or the Dean of Student Life and **cannot keep information confidential**. If you would rather share information about sexual harassment or sexual violence to a confidential employee who does not have this reporting responsibility, you can contact a confidential advocate at 503-725-5672 or by scheduling on-line (https://psuwrc.youcanbook.me) or another confidential employee found on the sexual misconduct resource webpage (https://www.pdx.edu/sexual-assault/get-help).

Disabilities

If you have, or think you may have, a disability that may affect your work in this class and feel you need accommodations, contact the Disability Resource Center to schedule an appointment and initiate a conversation about reasonable accommodations. Visit the DRC online at https://www.pdx.edu/disability-resource-center. If you already have accommodations from the DRC, please contact the instructor so we can discuss them.

Recording

This class may be recorded. Our use of recording technology is governed by FERPA, the Acceptable Use Policy, and PSU's Student Code of Conduct. A record of all meetings and recordings is kept and stored by PSU, in accordance with the Acceptable Use Policy and FERPA. The instructor will not share recordings of your class activities outside of course participants, which include your fellow students, TAs/GAs/Mentors, and any guest faculty or community based learning partners that we may engage with. You may not share recordings outside of this course. Doing so may result in disciplinary action.

Tentative Schedule

This schedule is highly subject to change. You should always attempt to do the reading *before* the relevant class meeting.

Readings are chapters from Pierce or named handouts (available on the course web page).

dates	Reading	topics
Apr 2 & 4	1,(2),3,4; Contexts Handout	Introduction; Syntax and Operational Semantics
Apr 9 & 11	5,6,7	Untyped lambda-calculus
Apr 16 & 18	8,9,10	Types; Simply-typed lambda-calculus
Apr 23 & 25	11	Extensions to lambda-calculus
Apr 30	12	References
May 2		**Midterm** (in-class)
May 7 & 9	IMP Handout	IMP and Denotational semantics
May 14 & May 16	13; Normalization Handout	Normalization for STLC
May 21 & 23	20,22	Recursive Types; Type Reconstruction
May 28 & 30	23,24,25	Universal and Existential Types
Jun 4	TBA	TBA
Jun 6		No class
Jun 11		No final exam
Jun 14		Final exercise due