CS 465: Language, Logic and Computation

Fritz Ruehr • Willamette University Computer Science • Spring 2019

Introduction

Language is the basis for complex communication, whether as natural language between humans or as formal language between humans and computers. In programming, different kinds of formal languages are crucial tools in all stages of development, from the logics used to specify requirements, to the programming languages used to implement algorithms, and the mathematical notations used to analyze their behavior. In this course we will study the general phenomenon of formal language by exploring the syntax, semantics, and logics of a broad range of examples, beginning with the simplest numeral notations and operator algebras and continuing through to computationally complete languages and sophisticated type systems. In addition to studying abstract descriptions of syntax and semantics, students will reinforce their understanding by implementing language-based tools in a functional meta-language.

Instructor

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`http://www.willamette.edu/~fruehr/465`

Office hours: M 4:00-5:00; Th 1:00-2:00; or by appointment!

Logistics and attendance

Event	Day and time	Room
Lectures	MWF 1:50-2:50 pm	Ford 204
Labs	MWF 3:00-4:00 pm	Ford 224

Students are expected to attend all lecture sessions unless arrangements have been made in advance—lab session attendance may vary somewhat depending on scheduling issues and need, but you should make sure that you have some lab time available each week. You are in any case responsible for all content, changes in assignments or policies, etc., which are made during the course of scheduled classes. I will try to make important announcements available on the course homepage or by e-mail.

Suggested textbooks *(NOT required!)*

No formal textbook will be used in this class, so your primary sources for information will be lecture (and the notes you take there), class hand-outs, lab assignments and possibly readings assignments based on web-accessible material. You should be careful to make arrangements to get lecture notes from someone else in class if you cannot attend.

If you need a reference for the Haskell programming language (which we will use throughout the course), I recommend one of the following. The first has been used in other Willamette courses , so used copies may be available; the second is available for physical purchase, but is also free on-line!

Programming in Haskell, by Graham Hutton. ISBN: 0-521-69269-5

Learn You a Haskell for Great Good, by Miran Lipovaca. `<http://learnyouahaskell.com/>`

Other on-line resources

The course homepage (address above) will fill out over the semester. Among other things, it will include links to on-line references which will provide background for many topics in the course. A Haskell system and editor are available in lab—for downloading a system for use at home, see links on the course homepage.

Due dates

Homework will generally be due a few class sessions after it is assigned—on occasion, class-wide extensions may be announced. If you think you will not be able to complete an assignment, contact me as soon as possible: extensions may be granted for official business, emergencies, etc. It is better to ask for an extension *before* the due date, if possible.

Exam

The final exam is scheduled for ***Friday, May 10, 2019, from 2-5 pm***. The mid-term exam date will be announced in lecture.

(Note: please make your summer travel plans accordingly!)

Grading policy

Grades will be based on exams, in-class quizzes, homework assignments, programming labs, and class participation. Individual grades will be given in numeric form and then combined to determine a composite at the end of the semester, according to the numeric weights listed below. I grade on a modified curve basis; that is, I grade students relative to each other's performance, but without requiring a "fit" to a normal curve. I am happy to give out all high grades (and will give out all low grades if necessary), depending on the absolute performance of the class as a whole.

I plan to give one midterm exam and a longer, comprehensive final exam during the regular scheduled period, as well as perhaps a few shorter in-class quizzes. The weights used for the final grade will be:

- 45% for the exams (split equally for the midterm and final);
- 25% for written homework and any in-class quizzes; and
- 20% for programming labs; and
- 10% for class participation.

Collaboration and related issues

All work you hand in should be your own. You are allowed (and encouraged) to seek help from other students for general study purposes, but you should never allow other people to do your work for you. You are also responsible for attributing any material you quote from outside sources, including other students (this is especially relevant for homework assignments). Violations of these rules will result in penalties according to the usual College policies, but would normally include at least a failing grade for the assignment, and possibly a failing grade for the course.

Potential topic list *(we will need to make some selections, as this list is too ambitious!)*

- introduction to language and formalism
- the FAST type system
- symbols, sequences and strings
- natural numbers, numerals and the numeric hierarchy
- aspects of infinity
- algebraic operators and terms
- variables and substitution
- polynomials
- propositional logic
- theories, models and power rings
- regular expressions and finite automata
- context-free grammars
- first-order logic
- lambda calculus and combinators
- Turing machines and computability
- advanced type systems

College-wide policies

Accreditation information

In accordance with college accreditation initiatives, the following are the ***student learning objectives*** associated with this class (SLO numbers are relative to CS Department norms):

CS/SLO #1: "Students will achieve proficiency in discrete math."

CS/SLO #2: "Students will achieve proficiency in Computer Science skills (fundamentals of programming, computer organization, architecture, algorithms, theory, designing and implementing software)."

CS/SLO #5: "Students will demonstrate the ability to work independently to analyze and solve problems."

Time commitment for this course

"Willamette's Credit Hour Policy holds that for every hour of class time there is an expectation of 2-3 hours work outside of class. Thus, for a class meeting three days a week you should anticipate spending 6-9 hours outside of class engaged in course-related activities. Examples include study time, reading and homework assignments, research projects, and group work."

ADA compliance

"Please tell me about any disabilities that will affect your participation in this course. I will respect any accommodations authorized by the Office of Disabilities Services."

Plagiarism and cheating

For full details of the College policies and procedures regarding plagiarism and cheating, see:

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http://www.willamette.edu/cla/catalog/resources/policies/categories/plagiarism_c heating.php
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Important dates

For the official college academic calendar for this year, see:

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http://www.willamette.edu/dept/registrar/calendar/cla/index.html
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Commitment to Positive Sexual Ethics

Willamette is a community committed to fostering safe, productive learning environments, and we value ethical sexual behaviors and standards. Title IX and our school policy prohibit discrimination on the basis of sex, which regards sexual misconduct — including discrimination, harassment, domestic and dating violence, sexual assault, and stalking. We understand that sexual violence can undermine students' academic success, and we encourage affected students to talk to someone about their experiences and get the support they need. Please be aware that as a mandatory reporter I am required to report any instances you disclose to Willamette's Title IX Coordinator.
If you would rather share information with a confidential employee who does not have this responsibility, please contact our confidential advocate at confidential-advocate@willamette.edu. Confidential support also can be found with SARAs and at the GRAC (503-851-4245); and at WUTalk - a 24-hour telephone crisis counseling support line (503-375-5353). If you are in immediate danger, please call campus safety at 503-370-6911.