

CS 6968: Web Browser Internals

Mon/Wed 15:00—16:30 in WEB 1460

Instructor: Pavel Panchekha (pavpan@cs.utah.edu)

Office Hours: Tues 13:00—14:00 in MEB 2174

While web browsers are ever-present, few have seen the insides of a browser. This course covers all major components of a web browser (including networking, parsing, layout, rendering, chrome, interfacing with JavaScript, security), developing a simplified implementation of each and dissecting implementations in existing browsers. Students will complete programming assignments and a course project, and read and present recent research papers in the field.

Course Content

First Half: Writing a Web Browser

Second Half: Reading Research Papers

Assignments and Grading

Assignments

Presentations

Grading and Feedback

Schedule

Course Policies

Course Expectations

School and University Policies (see Handbook)

Course Content

The goal of this course is to answer two questions: how do web browsers work, and what is current research on them? The course will consist of two parts. In the first, we will implement a toy web browser, including every major component from networking to typography. In the second, we will read recent research papers related to web browser implementation.

First Half: Writing a Web Browser

The first half of the course will develop a toy web browser. While not the sort of browser you could use daily, this toy browser will contain all of the major components of a modern browser: networking, a graphical UI, text layout, HTML parsing, block layout, stylesheets, browser chrome, web forms, web scripts, incremental reflows, security, and typography.

To develop the browser, the class will step through 12 labs during the first 8 weeks of class. You are expected to read the readings and implement a browser of your own (using any language of your choice). The labs are not supposed to be difficult, and the class readings will provide a complete walk-through (including code in Python).

The instructor's implementation of the labs totals roughly 1000 lines of code. There is no length limit or minimum for student implementations, but avoid writing thousands of lines of code for any lab; that is probably not a good implementation strategy.

Second Half: Reading Research Papers

The second half of the course will read research papers touching on web browser implementation and web application analysis. The papers will come from a variety of disciplines, such as HCI, PL, systems, security, and information retrieval. All papers will be recent: the web moves quickly, and few papers published prior to 2000 have any relevance. Papers will be selected by the instructor, but suggestions from students are appreciated.

Assignments and Grading

The course workload will consist of readings, presentations, labs, and a project.

First Half. Each class will cover one component of a web browser. The readings will walk through a lab implementing that component, which students are expected to do

before class, and then to submit questions and comments to answer in class. In each class, one student will present their implementation, and several extensions they made to it.

Second Half. Each class will cover a research paper or blog post. Students are expected to read the paper or blog post before class, and then to submit questions and comments to answer in class. In each class, one student will present the paper and lead a discussion. Students will also complete a course project.

Assignments

Readings. Each class will feature a reading; students should complete the reading before class. In the first half, readings will step through each lab; in the second half, readings will be a research paper or blog post. Each reading is expected to take approximately two hours to do, though papers may take longer for students unfamiliar with reading academic writing.

Comments. After each reading, students should submit questions on the reading. Submitting questions (at least one) is mandatory, and is part of the participation grade.

Labs. The first half of the course will write a toy web browser over a series of 12 labs.

Presentations. In each class, one student will present. These presentations should last roughly 20 minutes, with another 10 minutes for discussion or questions. Presentations are an important part of academic communication.

Project. The course project can be anything related to the web, from browser implementation to web testing to measurement. There will be some project suggestions but feel free to suggest your own. The project will include a 1-page proposal, a 7-minute proposal presentation, two 7-minute milestone presentations, and a 15-minute final presentation.

Presentations

In the first half, presentations should walk through a student's implementation of the lab, show the code, demo the resulting functionality, and explain solutions to lab's exercises. In the first half, presentations need not have slides; I expect you to use your text editor to show source code, run that code from the command line, and similar.

In the second half, presentations should present the paper. A presentation should explain the paper's context, the main approach, and its strengths. It should also

demonstrate the tool, discuss ways to apply or extend it, and note any impact the paper has had.

Presentations take a while to make! Expect to spend roughly four hours preparing a 20-minute class presentation, and to practice it twice before actually giving it. It is a good idea to list a half-dozen questions you expect to be asked.

Presentations may use any presentation software except LaTeX-based tools like Beamer. Keynote, Google Docs, Powerpoint, and Libreoffice are all good choices. Beamer and similar tools are not allowed, because they teach bad presentation habits and almost always result in poor-quality presentations.

Grading and Feedback

Grading. Course grades will be based on the project (35%), project proposal and presentations (5%, 5%, 5%, and 10%), reading presentations (25%), and participation (15%, equally split between attendance, class discussion, and reading comments). As a graduate-level special-topics course, grading is not expected to be difficult.

Feedback. Students will have the option to provide feedback after every class. That feedback can discuss the clarity of the reading, lecture, or student presentation; and also note which topics were interesting to and which were not. Class feedback will not affect grades in any way.

Schedule

Week 1: Course introduction; Browser components; Networking

Week 2: Graphical UIs; Font rendering; Text layout; Unicode

Week 3: Parsing HTML; The HTML 5 parsing algorithm

Week 4: Block layout; User styles; Layout modes

Week 5: Browser chrome; Links and History; Forms; CGI

Week 6: Web scripts; Events; Incremental Reflows

Week 7: Same-origin policy; Plugins; Ligatures; Hyphenation

Week 8: Project proposals due; WebRTC, WebAssembly

Week 9: Accessibility; Cross-cultural design

Week 10: Project milestone presentation, Undetermined paper

Week 11: Undetermined papers

Week 12: Undetermined paper, Project milestone presentation

Week 13: Attribute grammars; Parallel layout

Week 14: VizAssert; Troika

Week 15: Final project presentations

Course Policies

Attendance policy. Absences from lecture without 24 hours' notice will lower the participation portion of your grade by 5 points (out of 100), except in exceptional circumstances.

Late policy. The main assignments in the course are class presentations; these naturally cannot be late. Please take care to swap presentation days with other students if you cannot attend a class. In exceptional circumstances, the instructor may take on a presentation, with the presentation to be made up on a later date.

Course Expectations

This course will only work if students and faculty have the same expectations of one another.

I expect you, **the students**, to *complete readings* ahead of class, to *submit questions before class* or to *raise questions during class*, and to *prepare class presentations in advance*. You are expected to *treat one another with respect* and to *exert yourself on course projects*.

You may expect me, **the instructor**, to give you *constructive criticism on presentations* (including grades), to be *present during office hours*, and to *respond to your feedback*. You may also expect *sufficient notice* of class cancellations, changes to readings or paper selections, barring exceptional circumstances.

School and University Policies (see [Handbook](#))

The Americans with Disabilities Act. The University of Utah seeks to provide *equal access to its programs, services, and activities for people with disabilities*. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. *All written information in this course can be made available in an alternative format* with prior notification to the Center for Disability Services.

Addressing Sexual Misconduct. Title IX makes it clear that *violence and harassment based on sex and gender (which includes sexual orientation and gender identity/ expression) is a civil rights offense* subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, (801) 581-8365, or the Office of the Dean of Students, 270 Union Building, (801) 581-7066. For support and confidential consultation, contact the Center for Student Wellness, SSB 328, (801) 581-7776. To report to the police, contact the Department of Public Safety, (801) 585-COPS (801-585-2677).

Campus Safety. The University of Utah values the safety of all campus community members. To report suspicious activity, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safeu.utah.edu.

Personal Names. Class rosters are provided to the instructor with the student's legal name as well as "Preferred first name" (if previously entered by you in the Student Profile section of your CIS account, which managed can be managed at any time). While CIS refers to this as merely a preference, I will honor you by referring to you with the name and pronoun that feels best for you in class or on assignments. Please advise me of any name or pronoun changes so I can help create a learning environment in which you, your name, and your pronoun are respected. If you need any assistance or support, please reach out to the LGBT Resource Center.

Diversity and Inclusion. It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

Undocumented Student Support. Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles to engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families. To learn more, please contact the Dream Center at 801.213.3697 or visit dream.utah.edu.

Personal Health. Personal concerns such as stress, anxiety, relationship difficulties, depression, cross-cultural differences, etc., can interfere with a student's ability to succeed and thrive at the University of Utah. For helpful resources contact the Center for Student Wellness at www.wellness.utah.edu or (801) 581-7776.

Veterans. If you are a student veteran, the U of Utah has a Veterans Support Center located in Room 161 in the Olpin Union Building. Hours: M-F 5-8pm. Please visit their website for more information about what support they offer, a list of ongoing events and links to outside resources: <http://veteranscenter.utah.edu/>. Please also let me know if you need any additional support in this class for any reason.

English as a Second Language. If you are an English language learner, please be aware of several resources on campus that will support you with your language and writing development. These resources include: the Writing Center (<http://writingcenter.utah.edu/>); the Writing Program (<http://writing-program.utah.edu>); the English Language Institute (<http://continue.utah.edu/eli/>). Please let me know if there is any additional support you would like to discuss for this class.

Changes to the Syllabus. This syllabus is meant to serve as an outline and guide for our course. Please note that I may modify it with reasonable notice to you. I may also modify the Course Schedule to accommodate the needs of our class. Any changes will be announced in class and posted on Canvas under Announcements.