

Theory of computation

Instructor:	Fang Song
Course Meeting Schedule:	M/W 14:00 – 15:15 @ EB 92
Email:	fsong@pdx.edu Start email subject line with “f24-581”
Course webpage:	https://fangsong.info/teaching/f24_581_toc/
Office hours:	TBD

Course Description

Computation is a familiar term to all computer scientists. But what is computation after all? What problems are computable (Computability), and how “efficient” can we compute them (Complexity)? This course will be investigating these fundamental questions. The discussion on computability will be reviewing and reinforcing what has been covered in a typical undergraduate course on theory of computation. Then we will focus on computational complexity, including time, space, randomness complexity. We will also touch on selected advanced topics such as interactive proof systems and quantum computing.

Course Objectives

Upon the successful completion of this class, students will be able to:

1. improve mathematical thinking skill and habits, including thinking precisely about definitions, stating assumptions carefully, critically reading arguments, and being able to write convincingly.
2. understand and describe automata, Turing machines, and related computational models.
3. describe time complexity classes and their relationships (e.g., P vs. NP), and show NP-completeness by reductions.
4. describe and analyze space complexity classes, e.g., L, NL, and PSPACE.
5. describe randomized computation classes, analyze randomized algorithms.
6. understand and apply basic techniques to prove hardness (lower bound) results.
7. understand and analyze interactive proof systems.

Course Prerequisites

CS 311 or equivalent. You must be comfortable with reading and writing mathematical proofs.

Readings

(* is required, others recommended.)

- ***[S3]** Michael Sipser. *Introduction to the Theory of Computation*, 3rd ed. Cengage Learning, 2012.
- **[AB]** Sanjeev Arora, Boaz Barak. *Computational complexity: a modern approach*. Cambridge University Press, 2009. PSU Library [Link](#)
- **[W]** Avi Wigderson. *Mathematics and Computation*. Princeton University Press, 2019. [Link](#)

Grading Policies

- Homework: 40%.
- Quizzes: 25%.

- Exam: 30%.
- Participation: 5%.

Homework Policy

- You have a quota of 5 days in total for late submissions of homework or quizzes without penalty. You can use them at your will. Once the quota runs out, no late submissions will be accepted.
- Quizzes must be completed on your own.
- Collaboration on homework problems is highly encouraged, but you must write up solutions entirely on your own and clearly list who you discussed with for each problem. You may NOT use solutions found online.
- All assignments must be typeset in LaTeX and submitted in PDF format.

Course Topics and Tentative Schedule

Check course webpage for details and updates

Week	Topic	Suggested Reading
1 - 3	Intro, math proofs, basic models, Turing machines, diagonalization, decidability.	S3 0 – 5
4 – 6	Time complexity, P vs NP, NPC, EXP, time hierarchy.	S3 7,9
7 – 8	Space complexity, L, NL, PSPACE.	S3 8,9
9	Circuit complexity, randomization computation.	S3 10, AB 7
10	Interactive proofs and selected topics.	S3 10, AB 8

PSU Policies & Resources

Academic Integrity

Academic integrity is a vital part of the educational experience at PSU. Please see the [PSU Student Code of Conduct](#) for the university's policy on academic dishonesty. A confirmed violation of that Code in this course may result in failure of the course.

Recording Technology Notice

We will use technology for virtual meetings and recordings in part of this course. Our use of such 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. I 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 this course. Doing so may result in disciplinary action.**

Student Services

Disability Access Statement

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. The DRC is located in 116 Smith Memorial Student Union, 503-725-4150, drc@pdx.edu, <https://www.pdx.edu/disability-resource-center/>

Safe Campus Statement

Portland State University desires to create a safe campus for our students. As part of that mission, PSU requires all students to take the learning module entitled Creating a Safe Campus: Preventing Gender Discrimination, Sexual Harassment, Sexual Misconduct and Sexual Assault. If you or someone you know has been harassed or assaulted, you can find the appropriate resources on PSU's Enrollment Management & Student Affairs: Sexual Prevention & Response website at <http://www.pdx.edu/sexual-assault>

Title IX Reporting

As an instructor, one of my responsibilities is to help create a safe learning environment for my students and for the campus as a whole. Please be aware that as a faculty member, I have the responsibility to report any instances of sexual harassment, sexual violence and/or other forms of prohibited discrimination. If you would rather share information about sexual harassment, sexual violence or discrimination to a confidential employee who does not have this reporting responsibility, you can find a list of those individuals on PSU's Enrollment Management & Student Affairs: Sexual Prevention & Response website at <http://www.pdx.edu/sexual-assault>.

Discrimination and Bias Incidents

[The Office of Equity and Compliance](#) (OEC) addresses complaints of discrimination, discriminatory Harassment, and sexual harassment against employees (faculty and staff). If you or someone you know believes they have been discriminated against, you may file a complaint. Someone from the OEC will contact you to discuss how to best address your complaint.

[The Bias Review Team](#) (BRT) gathers information on bias incidents that happen on and around campus, and gives resources and support to individuals who experience them. You can report a bias incident you experienced or learned about. A member of the BRT will contact you if you indicate you would like to be contacted.

Religious Accommodations

If you would like to obtain religious accommodations, such as flexibility in attending evening courses or extension on assignments, please contact your instructors. If you need additional assistance, please contact the Office of the Dean of Student Life (DOSL) by emailing askdos@pdx.edu.

Cultural Resource Centers

Cultural Resource Centers (CRCs) create a student-centered inclusive environment that enriches the university experience. They honor diversity, explore social justice issues, celebrate cultural traditions, and foster student identities, success, and leadership. They provide opportunities for student leadership, employment, and volunteering; student resources such as computer labs, event, lounge, and study spaces; and extensive programming. All are welcome!

- Multicultural Student Center
- La Casa Latina Student Center
- Native American Student and Community Center
- Pan African Commons
- Pacific Islander, Asian, and Asian American Student Center
- Middle East, North Africa, South Asia Initiative

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COVID-19 Response

The University has established rules and policies to make the return to the classroom as safe as possible. To learn about Portland State's activities to reduce the spread of COVID-19, visit [PSU's COVID-19 Response page](#).