Fall 2025 CS 581

Theory of computation

Instructor:	Fang Song
Course Meeting Schedule:	M/W 11:00 - 12:15 @ Shattuck Hall 210
Email:	fsong@pdx.edu Start email subject line with "f25-581"
Course webpage:	https://fangsong.info/teaching/f25_581_toc/
Office hours:	M 09:45 – 10:45 @ FAB 120-25 and by appointment

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: 45%.
- Quizzes: 15%.

- Exam: 35%.
- Participation: 5%.

Information on [PSU Grading System](#) and the [Incomplete Grades Policy](#).

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 run out, no late submissions will be accepted.
- Quizzes must be completed on your own without any external references.
- 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. (See AI policy below.)
- 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

Flexibility Statement

The instructor reserves the right to modify course content and/or substitute assignments and learning activities in response to institutional, weather, or class situations.

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.

AI Policy
In this course, AI tools, such as ChatGPT, are permitted. However, to uphold scholarly standards, students are required to cite any AI-generated material that contributes to their work, including in-text citations, quotations, and references. If you have consulted AI tools on homework problems, you must describe how you interacted with them. You may NOT directly search for and use solutions via

AI or elsewhere online. You may be asked to explain your solutions to the course staff. The generation of content through AI without appropriate attribution constitutes academic misconduct.

Student Support Resources
- [How to Find Help at PSU](#)
- [Access and Inclusion for Students with Disabilities](#)
- [Understanding Sexual Misconduct](#)
- [Title IX Reporting](#)
- [Religious Accommodations](#)

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.**

Turnitin

Students agree that all required papers may be subject to submission review for textual similarity for the purpose of detection of unoriginal writing, including plagiarism. All submitted papers will be included as source documents in the [Turnitin.com](#) reference database solely for the purpose of detecting unoriginal writing, including plagiarism of such papers. Use of the Turnitin.com service is subject to the Turnitin Acceptable Use.

In Case of Emergency

- **Call 9-1-1 for Emergencies**: Immediate threat to life and safety For issues such as a medical emergency, urgent violent incident, fire, etc., you can also call 503-725-5911

- **Call 503-725-4407** for Non-Emergencies: [Campus Public Safety Office (CPSO)](#) – Non-Emergency. For non-emergency issues such as vandalism, disturbance, suspicious person, theft, suspicious packages, access control, etc.