CS 535: Complexity Theory, Fall 2026

Research Reading Project Instructions

The reading project for CS 535 is an opportunity to explore a topic in complexity theory that interests you. The goals are to gain experience

- Independently reading and synthesizing research papers,
- Presenting research papers to an audience of your peers, and
- Critically evaluating written technical work.

Your task is to review and present a research article or survey in complexity theory on a topic we did not cover in detail in class. **You may work on the project either individually or in pairs.** The presentation should be targeted to other students in the class—in fact, an important component of the project will be reviewing each other's work and providing constructive feedback. You can assume they are familiar with the topics we've studied (time/space complexity, boolean circuits, randomized computation, interactive proofs, the statement of the PCP theorem, counting complexity), but not necessarily with the specific models and definitions in the topic you are investigating.

There are three deliverables for this project:

1. A short written report (3-5 pages). You can think of this as an expanded set of lecture notes for your presentation. As I cannot hold you to a higher standard than I hold myself :), a report at the level of detail, (in)formality, and polish of our course lecture notes is perfectly adequate for this.

2. An oral presentation in tutorial, discussion, or lecture during the last week of class (exact details TBD pending timing constraints and student interest). You may use slides or the whiteboard/chalkboard — whatever helps you best communicate. Plan for 15-20 minutes for presentations, plus 5 minutes for questions.

3. A few paragraphs of peer feedback to be shared with one other project team.

Some suggestions for potential project topics will be distributed on Piazza. You are not required to choose from among these topics and are encouraged to select your own, especially if they relate to your research interests.

Your project should focus on teaching your classmates **one technical idea** from the paper you are reading. This could be a main theorem or an illustrative special case of one, an insightful lemma, the central step in a reduction, or an algorithm together with its resource usage and correctness arguments. Choose something that exemplifies an important contribution of the paper and that you can explain to your classmates with a modest amount of background.

You should understand the main questions the paper addresses and how your chosen argument contributes to its results. But you do not need to master every part of the paper. In selecting your focus, aim for an argument you can understand thoroughly rather than a collection of results you can describe only at a high level.

Your written report should briefly introduce the problem and its significance, give a precise statement of your chosen claim, and explain its proof in your own words. Introduce the definitions and preliminary facts needed to follow the argument. You may use supporting results as "black boxes", provided you state them clearly and explain precisely how you use them. The central argument you choose to study should receive enough detail that a classmate can understand why it works.

Your explanation should include at least one piece of "added value" above the original paper. For example, you could:

- Work through a concrete example that the paper does not provide,
- Supply a step that the paper leaves implicit,
- Explain where an assumption is used and what can go wrong without it, or
- Simplify a complex argument by restricting attention to an illustrative special case.

Original creative research is obviously welcome, but not required for this. Clearly identify what comes from the paper and what you have added.

Your oral presentation should cover the main ideas from your report, but not necessarily every detail. In 15-20 minutes, aim to teach your classmates one construction or proof idea. Explain motivation and background briefly with the goal of spending most of the time on the technical argument. Appeal to a worked example or special case when helpful. Some details can remain deferred to the written report. Conclude by explaining how the idea you presented contributes to the paper's larger results and goals.

Be prepared to answer questions about your chosen argument. For example, we (Mark, Mandar, and your classmates) might ask why a particular step is valid, where an assumption is needed, or how the construction behaves on a small example. If you work in a pair, both partners should be able to explain the technical content.

Topic Selection (Friday 11/13, 0.5%) Submit to Gradescope the title and authors of the paper you are reviewing, your project partner (if applicable), and timing constraints/preferences for the last week of classes. Please also include a sentence or two identifying the claim, construction, or argument you tentatively plan to explain. This choice is non-binding and may evolve as you read.

Written Report Due (Friday 12/4, 3.5%) Upload your report to Gradescope, and we will share them with the class on Piazza. (So your classmates have them available to supplement your presentation.)

Oral Presentation (Week of 12/7, 6.5%)

Peer Feedback (Friday 12/11, 1.5%) We will assign everyone a peer to provide a few paragraphs of respectful and constructive feedback on both the written report and the oral presentation. What did the presenter(s) do well? What could they improve? Are the proofs convincing? Is enough intuition provided to support the technical statements? Are there any places that are unclear or where special knowledge is assumed?