CSCE 424/824: Computational Complexity Theory

Room: CBA 306  
Instructors: Derrick Stolee  
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Time: TR 9:30–10:45am  
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Textbook: Computational Complexity: A Modern Approach, by Arora and Barak

Prerequisites: The main prerequisite for this course is mathematical maturity, as we will be delving deeply into the mathematical theory of computation. Courses such as CSCE 423/823: Design and Analysis of Algorithms or CSCE 428/828: Automata, Computation and Formal Languages are recommended, but not required. Also, courses in combinatorics and graph theory (MATH 450, 850, or 852) are also helpful.

Goals: We will discuss the fundamentals of computational complexity theory as well as investigate some of the recent results on the edges of current research. The course shall begin by discussing the core topics of complexity theory. From this base of fundamental knowledge, we shall venture into special topics based on student preference. The topics are listed below.

Core Topics: These topics will be discussed in sequential order.

- Chapter 1: The computational model.
- Chapter 2: NP and NP-completeness.
- Chapter 3: Diagonalization.
- Chapter 4: Space complexity.
- Chapter 5: The polynomial hierarchy and alternations.
- Chapter 6: Boolean circuits.
- Chapter 7: Randomized computation.

Special Topics: These topics will be discussed in order of student preference.

- Chapter 8: Interactive proofs.
- Chapter 11: PCP theorem and hardness of approximation.
- Chapter 12: Decision trees.
- Chapter 13: Communication Complexity.
- Chapter 14: Circuit lower bounds.
- Chapter 17: Complexity of counting.
- Chapter 19: Hardness amplification and error-correcting codes.
- Chapter 20: Derandomization.
- Chapter 21: Pseudorandom constructions: Expanders and extractors.

Students are expected to meet with the instructor to discuss preferences for the special topics. These meetings will be requested near the end of the discussions of core topics.

Grading: The course grade will be based on a combination of problem sets (60%), a final exam (30%), and class participation (10%).

There will be a problem set approximately every 2-3 weeks (5 or 6 total). One problem on each problem set will be required of graduate students and optional for undergraduates. It is recommended that students discuss the problem sets in order to develop intuition and high-level approaches to the problems, but every student must turn in a self-written, typed solution set. Use of \LaTeX is encouraged, but solutions may be written using other typesetting systems, such as Microsoft Word. Any necessary figures may be hand-drawn.
The final exam will be comprehensive and split into a take-home and in-class portion (each part is worth 15% of the full grade). The take-home exam will be assigned in class on Thursday, April 19th and due 10:00am on Thursday May 3. The in-class final is scheduled for 10:00 to 12:00 noon Thursday, May 3 in CBA 306.

Class participation involves attendance, attentiveness, and involvement in class discussions. Also included are discussions held in office hours, including the mandatory meeting for discussing special topics preferences.

Letter grades will be assigned using the following lower bounds on total grade percentage:

- A+ 97%
- A  93%
- A− 90%
- B+ 87%
- B  83%
- B− 80%
- C+ 77%
- C  73%
- C− 70%
- D+ 67%
- D  63%
- D− 60%

Policies: All students are expected to be attentive and participate in class. In the event of an unavoidable absence, please notify the instructor as soon as possible.

Students are encouraged to discuss approaches to problem sets, in order to develop intuition and high-level approaches to the problems, but every student must turn in their own solutions. If you discuss a problem with another student, please list that student’s name on your solution. Students are not allowed to discuss any part of the take-home final with other students. All questions must be directed to the instructors. The in-class portion of the final is closed book and closed notes.

There is a zero tolerance policy to plagiarism. This includes copying solutions from internet sources or receiving inappropriate help from other students. Violating this policy will result in a failing grade.

All behavior in the classroom must reflect respect for the instructor and other students.

Special Circumstances: If you have a circumstance that prevents you from performing to your utmost capacity in this class, such as a learning disorder or physical handicap, make sure you get in contact with UNL Services for Students with Disabilities (SSD) (http://www.unl.edu/ssd).

The instructors reserve the right to modify this course.