CSC 573 - Theory of Computation (Spring 2017)
Gould Simpson 906, Tuesday and Thursday, 12:30-1:45pm

Description of Course
This course assumes prior familiarity with the topics of finite automata, context-free grammars and Turing machines, such as found in the undergraduate version of the course, CSc 473.

The course begins by reviewing properties of major language classes in the Chomsky Hierarchy, as well as computation models such as Turing machines. Unsolvable problems and reducibility are studied. The bulk of the course then focuses on what every student should know about machine-specific complexity theory, the interrelationships among complexity classes, and the study of both NP-complete and provably intractable problems. Topics covered include Church’s thesis, undecidability, randomized algorithms, and approximation algorithms.

The course stresses methods for formal reasoning and modeling of general computation. The emphasis will be on written problem sets containing challenging problems. The key techniques to be learned are those of simulation of one computational model by another, reduction of one problem to another, and methods for classifying problem complexity.

Course Prerequisites
CSc473: "Automata, Grammars and Languages" is a required prerequisite. Without 473 or an equivalent from elsewhere (typically entitled "Languages and Automata") the likelihood of success in this course is small. We will need specific material and facts from the prerequisite course and, more importantly, the mathematical maturity and methods of thought introduced there, and the ability to use standard language and notation.

The prerequisite material needed from CSc 473 is represented by Chapters 0-3 of Sipser's text. It is assumed you are familiar with the following topics: strings and sets (languages), DFAs, NFAs, PDAs, regular sets, CFLs, Turing Machines, nondeterminism, definitions of machine acceptance and the language accepted by a machine, the connection between types of grammars and types of machines, operations on languages such as union, and closure properties of regular sets and CFLs.

Instructor and Contact Information
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Office Hours: 1:45-2:45pm Tuesdays and Thursdays and whenever my door is open.
  - Class webpage: http://www.cs.arizona.edu/classes/cs573
  - Instructor webpage: http://www.cs.arizona.edu/~kobourov
  - Grader: TBA

Course Objectives and Expected Learning Outcomes
Students who complete this course will be familiar with properties of major language classes in the Chomsky Hierarchy, computation models such as Turing machines, machine-specific complexity theory, the interrelationships among complexity classes, and the study of both NP-complete and provably intractable problems. Students will gain experience with methods for formal reasoning and modeling of general computation. Key techniques learned include simulation of one computational model by another, reduction of one problem to another, and methods for classifying problem complexity.

Absence and Class Participation Policy
The UA’s policy concerning Class Attendance, Participation, and Administrative Drops is available at http://catalog.arizona.edu/2015-16/policies/classatten.htm

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be
accommodated where reasonable: http://policy.arizona.edu/human-resources/religious-accommodation-policy.

Absences preapproved by the UA Dean of Students (or dean’s designee) will be honored. See http://uhap.web.arizona.edu/policy/appointed-personnel/7.04.02

Participating in the course and attending lectures and other course events are vital to the learning process. As such, attendance is required at all lectures. Students who miss class due to illness or emergency are required to bring documentation from their health-care provider or other relevant, professional third parties. Failure to submit third-party documentation will result in unexcused absences.

**Makeup Policy for Students Who Register Late**
Students who register after the first class meeting must make up missed assignments/exams by the assigned date.

**Course Communications**
Online communication will be conducted via piazza and students are expected to check the webpage daily: https://piazza.com/arizona/spring2017/cs573/home

**Required Texts or Readings**

Note that used copies of the second edition can be purchased for $35-40 at Amazon.

**Assignments and Examinations: Schedule/Due Dates**
- Preliminary exam (5%): Thursday, January 12, 1:15-1:45pm
- Midterm exam (20%): Thursday, March 9, 12:30-1:45pm
- Final exam (33%): Wednesday, May 10, 1:00-3:00pm
- Homework assignments (42%)

Without prior arrangement, missed exams and late homework assignments are not graded for credit.

There will be six homework assignments, assigned on Tuesdays and due in 2 weeks. Late homework will not be graded for credit. Failure to turn in a homework on time will result in a zero for that assignment. Yes, this lateness policy is harsh. Why? Because in the past, those who have fallen behind have had a very hard time catching up. So we are trying to prevent you falling behind. In the past, I have had students complain that they could have handed in something substandard on time and gotten more points than if they had handed in something really good a little late. Too bad. It is up to you to plan your time carefully and get your work in on time! You have been warned. In exceptional circumstances extra time can be requested. If you discuss with me well before the due date, requests will be considered reasonably.

**Grading:** Neat and concise solutions are required in order to receive full credit. If you cannot solve a particular problem, state this clearly in your write-up, and write down only what you know to be correct; rambling at length about ideas that don't quite work may cause additional points to be deducted. A problem solution that is technically perfect, but which is presented in a difficult-to-understand manner, might lose 10-20% of the available points.

**Extra credit:** Sometimes the homework assignments will have extra credit work. Extra credit in this course will be tallied separately from regular scores. If you end up on the borderline between two grades at the end of the course, extra credit will count in your favor. However, failure to do extra credit will never be counted against you, as grades are assigned on the basis of regular scores. You should do extra credit if you find it interesting and think that it might teach you something.

**Grading Scale and Policies**
Your final grade is based on the percentage of all available points that you receive. A typical example of
how percentages might translate into letter grades is A: 91-100, B: 81-90, C: 66-80, D:50-65, E:0-50.
I do not claim that the grade cutoffs for this class will be the same. These cutoffs are merely to give
you an idea of how I have graded in the past. I reserve the right to fail any student who has a failing
average on the homework portion, or on the exam portion, or on the comprehensive final exam.

University policy regarding grades and grading systems is available at
http://catalog.arizona.edu/2015-16/policies/grade.htm

Department of Computer Science Grading Policy:

1. Instructors will explicitly promise when every assignment and exam will be graded and
   returned to students. These promised dates will appear in the syllabus, associated with the
   corresponding due dates and exam dates.
2. Graded homework will be returned before the next homework is due.
3. Exams will be returned promptly, as defined by the instructor (within 2 weeks)
4. Grading delays beyond promised return-by dates will be announced as soon as possible with an
   explanation for the delay.

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University
policies, which are available at http://catalog.arizona.edu/2015-16/policies/grade.htm#I and
http://catalog.arizona.edu/2015-16/policies/grade.htm#W, respectively.

Dispute of Grade Policy: Instructor review of exam grades must be requested no later than one week
after the graded exam is returned to you. Be aware that as a result of such a review your grade is just
as likely to go down as it is to go up. Review of the grading for a homework assignment must be
requested first from the grader and then, if the issue is not resolved, from the instructor. This must be
done no later than one week after the graded assignment is returned to you. Be aware that as a result
of such a review your grade is just as likely to go down as it is to go up.

Scheduled Topics/Activities

Review: automata, languages, grammars, computability, complexity
Languages: regular, context free, decidable, undecidable
Machines: DFAs, NFAs, PDAs, Turing machines
Church-Turing Thesis: Turing machine variants, equivalence with other models
Algorithms: definitions and connections with Turing machines
Decidability: decidable and undecidable languages
Reducibility: computation histories and mapping reducibility
The Recursion Theorem: self-reference and recursion
Complexity Classes: the classes P and NP
The Cook-Levin Theorem: NP-completeness and polynomial-time reducibility
Space Complexity: The classes PSPACE, L, and NL.
Intractability: Approximation algorithms and randomized algorithms

Department of Computer Science Code of Conduct

The Department of Computer Science is committed to providing and maintaining a supportive
educational environment for all. We strive to be welcoming and inclusive, respect privacy and
confidentiality, behave respectfully and courteously, and practice intellectual honesty. Disruptive
behaviors (such as physical or emotional harassment, dismissive attitudes, and abuse of department
resources) will not be tolerated. The complete Code of Conduct is available on our department web
site. We expect that you will adhere to this code, as well as the UA Student Code of Conduct, while you
are a member of this class.

Classroom Behavior Policy

To foster a positive learning environment, students and instructors have a shared responsibility. We
want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and
where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on
extraneous activities (e.g., texting, web surfing, chatting, etc.).

Inclusive Excellence is a fundamental part of the University of Arizona’s strategic plan and culture. As
part of this initiative, the institution embraces and practices diversity and inclusiveness. These values are expected, respected and welcomed in this course.

**Threatening Behavior Policy**
The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself; see http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

**Elective Name and Pronoun Usage**
This course supports elective gender pronoun use and self-identification; rosters indicating such choices will be updated throughout the semester, upon student request. As the course includes group work and in-class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect.

**Accessibility and Accommodations**
Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit http://drc.arizona.edu.

If you have reasonable accommodations, please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate. Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

**Code of Academic Integrity**
Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

The University Libraries have some excellent tips for avoiding plagiarism, available at http://www.library.arizona.edu/help/tutorials/plagiarism/index.html.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor’s express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

**UA Nondiscrimination and Anti-harassment Policy**
The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

**Additional Resources for Students**
- UA Academic policies and procedures are available at http://catalog.arizona.edu/2015-16/policies/aaindex.html
- Student Assistance and Advocacy: http://deanofstudents.arizona.edu/student-assistance/students/student-assistance
- Office of Diversity information is available at http://diversity.arizona.edu/
- Campus Health information may be found here: http://www.health.arizona.edu/counseling-and-psych-services
- OASIS Sexual Assault and Trauma Services: http://oasis.health.arizona.edu/hpps_oasis_program.htm

**Subject to Change Statement**
Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.