CS21: Decidability and Tractability

course information and tentative schedule

Catalog description: This course introduces the formal foundations of computer science, the fundamental limits of computation, and the limits of efficient computation. Topics will include automata and Turing machines, decidability and undecidability, reductions between computational problems, and the theory of NP-completeness.

Course Information:

- Instructor: Chris Umans (`umans@cs.caltech.edu`)
- TAs:
  - William Hong (`cwhong@caltech.edu`)
  - Fedor Manin (`fmanin@gmail.com`)
  - Ila Varma (`ila@caltech.edu`)
- Lectures: Mondays, Wednesdays, and Fridays 1:00 – 1:55 in Jorgensen 74
- Office hours: TBD
- Text: *Introduction to the Theory of Computation – Second Edition* by Michael Sipser (required). The first edition should also suffice; the main difference is that it does not have solutions to selected problems. This text should be on reserve at the library.
- Webpage: `http://www.cs.caltech.edu/~umans/cs21/`

Homework: The homework is extremely important – for this material, the best way to learn is by doing. I strongly encourage you to work in groups of two or three on the homework. However, you must each turn in your own write-up and note with whom you worked. The rules on homework are:

- There are 7 problem sets. They are handed out at the end of the Wednesday lecture, and they are due at the beginning of the following Wednesday lecture.
- You may consult *only* the course notes (the posted lectures, and any notes you or others took during class) and the required text (Sipser).
- The quality (clarity, conciseness, neatness) of your write-up counts.
- You may elect to take a two-day extension (until 5pm Friday) on *one* problem set without penalty. Other problem sets turned in late, but before 5pm Friday, receive half credit. Late problem sets should be turned in by putting them into my mailbox on the 2nd floor of Jorgensen.

Exams: There will be a midterm and final exam. They will be indistinguishable from the problem sets, except that they will be cumulative, and you may not work with others on the exams. The homework rules apply to exams as well. There are no extensions for the exams, and no partial credit for exams that are turned in late.

Reading: The webpage will list reading in Sipser that parallels the lectures (when applicable). This is mainly for reference; the lectures are designed to be self-contained.

Feedback: If you have any comments or concerns on issues like: the pace of the lectures, the difficulty of the material, time spent on problem sets, or anything else, please let me know! You can tell me or the TAs directly, or you can talk to the course ombudsperson (we will select someone for this role after the first couple of lectures).

Evaluation and Grades: Your grade will be based on the following (weighted) components:

Homework 60%; Participation 10%; Midterm 15%; Final 15%.

If you earn 90% of the available (weighted) points you are guaranteed at least an A of some form, 80% guarantees at least a B of some form, 70% guarantees at least a C of some form, etc...

Tentative lecture schedule:

#	Date	Subject	Assignments	Reading
1	Jan. 7	Introduction; Finite Automata and Regular Expressions		
2	Jan. 9	Finite Automata and Regular Expressions		
3	Jan. 11	Finite Automata and Regular Expressions		
4	Jan. 14	Pushdown Automata and Context Free Grammars		
5	Jan. 16	Pushdown Automata and Context Free Grammars	HW1	
6	Jan. 18	Pushdown Automata and Context Free Grammars		
-	Jan. 21	NO CLASS: MLK Day (Institute Holiday)		
7	Jan. 23	Turing Machines, undecidability, and reductions	HW2	
8	Jan. 25	Turing Machines, undecidability, and reductions		
9	Jan. 28	Turing Machines, undecidability, and reductions		
10	Jan. 30	Turing Machines, undecidability, and reductions	HW3	
11	Feb. 1	Turing Machines, undecidability, and reductions		
12	Feb. 4	Turing Machines, undecidability, and reductions		
13	Feb. 6	Incompleteness Theorem	Midterm	
14	Feb. 8	Introduction to Complexity		
15	Feb. 11	Complexity Classes: P, EXP, and NP		
16	Feb. 13	Complexity Classes: P, EXP, and NP	HW4	
17	Feb. 15	Complexity Classes: P, EXP, and NP		
-	Feb. 18	NO CLASS: President's Day (Institute Holiday)		
18	Feb. 20	NP-completeness and reductions	HW5	
19	Feb. 22	NP-completeness and reductions		
20	Feb. 25	NP-completeness and reductions		
21	Feb. 27	NP-completeness and reductions	HW6	
22	Feb. 29	NP-completeness and reductions		
23	Mar. 3	More complexity classes		
24	Mar. 5	More complexity classes	HW7	
25	Mar. 7	Topics: randomized computation		
26	Mar. 10	Topics: quantum computation		
27	Mar. 12	Course summary and review	Final	
-	Mar. 19		Final due	

Lecture slides will be posted on the course webpage after each class.