CSE 5311-001: ADVANCED ALGORITHMS

Summer 2006: MW 10:30 a.m. - 12:20 p.m., Nedderman 110

Instructor: Bob Weems, Associate Professor
Office: 344 Nedderman (`weems@uta.edu, http://reptar.uta.edu`)
Hours: MW 3:00-4:30 pm

GTA 1:   Amit Vasudevan   GTA 2:   Pradip De
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Hours: M 12:30-3:30 pm   Hours: W 12:30-3:30 pm

Prerequisites: Algorithms & Data Structures (CSE 2320)
                 Theoretical Computer Science (CSE 3315)

Objectives: Deeper study of algorithms, data structures, and complexity classes.

Outcomes: 1. Exposure to more sophisticated analysis techniques, e.g. amortized complexity.
                 2. Exposure to specialized data structures and algorithms.
                 3. Exposure to models of algorithm design.

Textbook: Cormen, Leiserson, Rivest, Stein, *Introduction to Algorithms*, *2nd ed.*, MIT Press, 2001.
                 (Henceforth known as CLRS)

References: S. Baase, *Computer Algorithms, Introduction to Design and Analysis*, *3rd ed.*, Addison-Wesley, 2000.

                 M. de Berg et.al., *Computational Geometry: Algorithms and Applications, 2nd ed.*, Springer-Verlag, 2000.

                 M.R. Garey and D.S. Johnson, *Computers and Intractability: A Guide to the Theory of NP-Completeness*, Freeman, 1979.

                 G. Gonnet and R. Baeza-Yates, *Handbook of Algorithms and Data Structures, 2nd. ed.*, Addison-Wesley, 1991.

                 R.L. Graham, D.E. Knuth, and O. Patashnik, *Concrete Mathematics*, Addison-Wesley, 1989.

                 D. Gusfield, *Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology*, Cambridge University Press, 1997.

                 D. Gusfield and R. Irving, *The Stable Marriage Problem: Structure and Algorithms*, MIT Press, 1989.

                 D.S. Hochbaum, ed., *Approximation Algorithms for NP-Hard Problems*, PWS, 1997.

E. Horowitz and S. Sahni, *Fundamentals of Computer Algorithms*, Computer Science Press, 1978.

J. Kleinberg and E. Tardos, *Algorithm Design*, Addison-Wesley, 2006.

D.E. Knuth, *The Art of Computer Programming*, Vols. 1-3, Addison-Wesley.

R. Motwani and P. Raghavan, *Randomized Algorithms,* Cambridge Univ. Press, 1995.

J. O'Rourke, *Computational Geometry in C, 2nd ed.,* Cambridge Univ. Press, 1998.

C.H. Papadimitriou, *Computational Complexity*, Addison-Wesley, 1994.

R. Sedgewick, *Algorithms in C*, *Parts 1-5, 3rd ed.*, Addison-Wesley, 2001.

T. Standish, *Data Structure Techniques*, Addison-Wesley, 1980.

C.J. Van Wyk, *Data Structures and C Programs*, Addison-Wesley, 1988.

N. Wirth, *Algorithms + Data Structures = Programs*, Prentice-Hall.

Homework: Two assignments - NOT GRADED

Grade: Your grade will be based on the following weights:

    Exams: 80% (Test 1: 40%; Test 2: 40%, August 9, 10:30 a.m. -12:30 p.m.)
    Labs: 20% (Three labs, equal weight)

Policies:

1. Attendance is not required, but is highly encouraged. Consult me in advance if you must miss class for a good reason.

2. You are expected to have at least skimmed the new material by the day we start that material in class. The material will be covered in the order given later.

3. Homeworks, with solutions, are available from the course web page.

4. CHEATING - YOU ARE EXPECTED TO KNOW UNIVERSITY POLICIES. All cases of plagiarism will be processed through University channels outside the CSE department.

   a. **Academic Integrity Policy:** It is the policy of the University of Texas at Arlington to uphold and support standards of personal honesty and integrity for all students consistent with the goals of a community of scholars and students seeking knowledge and truth. Furthermore, it is the policy of the University to enforce these standards through fair and objective procedures governing instances of alleged dishonesty, cheating, and other academic/non-academic misconduct.

   You can assume responsibility in two ways. **First**, if you choose to take the risk associated with scholastic dishonesty and any other violation of the Code of Student Conduct and Discipline, you

must assume responsibility for your behaviors and accept the consequences. In an academic community, the standards for integrity are high. **Second**, if you are aware of scholastic dishonesty and any other conduct violations on the part of others, you have the responsibility to report it to the professor or assistant dean of students/director of student judicial affairs. The decision to do so is another moral dilemna to be faced as you define who you are. Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and dismissal from the University. Since dishonesty harms the individual, all students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced.

    b. **Statement on Ethics, Professionalism, and Conduct of Engineering Students**: The statement is attached. Continued failure to sign the statement will result in 1) late penalty on programming assignments and 2) failure on exams.

5. Any request for special consideration must be appropriately documented **in advance**. (Special consideration does not include giving a higher grade than has been earned.)

6. Late labs are penalized 30% per day, i.e. up to 10:15 a.m.. After the due date neither I, nor the GTAs, will provide assistance.

7. Each student will have available *one* 48-hour no-penalty extension that may be applied to *one* of the lab assignments. To use your extension you must send an email to the grader *before* the due time.

   RESUBMISSIONS BEFORE THE DUE TIME ARE PENALIZED 10 POINTS EACH. NO RESUBMISSIONS AFTER THE DUE TIME.

8. Phone calls. I will not answer my phone during office hours if someone is in my office. After the third ring the call is switched to the CSE office, so please leave a message with the secretary.

9. Please email the following information to `vasudeva@cse.uta.edu` by Wednesday, June 7:

   a. Name (as listed by the university).
   b. Additional email addresses.
   c. Special circumstances affecting your performance.
   d. What books were used in your previous course(s) in algorithms and data structures?
   e. (Optional) What do you hope to gain from this course?

Course Outline

Starred (*) topics are not in CLRS

1. Mathematical Preliminaries
      Recurrences - Master Method (4.3-4.4.1)
      Probability and Randomized Algorithms (5)
2. Binary Search Trees
      Rotations
      Red-Black Trees - Review (13)
      AVL Trees*
      Treaps

Augmenting Data Structures (14)
3. Amortized Analysis (17)
4. Self-Organizing Linear Search (Computing Surveys)*
5. Trees
   Optimal Binary Search Trees (15.5)
   Self-Adjusting Binary Search Trees (Splay trees/amortized analysis) (JACM)*
6. Skip Lists*
7. Priority Queues - Review (6.5)
   Binary Trees, Binary Heaps, d-heaps, van Emde Boas PQ, Leftist Heaps
   Binomial Heaps (19)
   Fibonacci Heaps (20)
8. Disjoint Sets (union-find trees) (21)
9. Hashing - Review, Brent's Rehash*, Perfect Hashing (11.5)
10. Medians/Selection (9.3)
11. Minimum Spanning Trees (23)
   Brief review of Prim
   Kruskal's Algorithm (application of union-find trees) and extension to detecting non-unique MST
   Boruvka's Algorithm
TEST 1
12. Max-Flow/Bipartite Matching (26)
   Ford-Fulkerson - review, maximum capacity paths
   Push-relabel methods
   Vertex and edge connectivity
13. Depth-First Search (22.3)
   Strong Components (review)
   Biconnected Components
18. Intractability (34, 35)
   Sample Intractable Problems
   Complexity Classes
   Reductions
   Polynomial-Time Approximation
16. Matrices
   Strassen's Matrix Multiplication (28.2)
17. Computational Geometry (33)
   Fundamental Predicates
   Closest Pairs
   Convex Hulls
   Sweepline Algorithms
15. Sequences
   Pattern-based
      Rabin-Karp Algorithm (32.2)
      Gusfield's Z Algorithm
      Knuth-Morris-Pratt Algorithm (32.4)
   Text-based - Suffix Trees and Suffix Arrays
   Longest Common Subsequences
      Dynamic Programming - Review and Linear Space Version
      Longest Strictly Increasing Subsequence Approach
14. Stable Marriages*
TEST 2

	May/June				July/August		
29	Holiday	31	Syllabus/1.	3	Holiday	5	Exam 1
5	1.	7	2.	10		12	12.
12	3./4.	14	4./5.	17	12./13.	19	13.
19	6./7.	21	8.	24	18.	26	18.
26	9./10.	28	11.	31	16./17.	2	15.
				7	14.	9	Exam 2

Monday, July 24 is the last day to withdraw.

Statement of Ethics - Student Confirmation
(CSE 5311, Summer 2006)

The following is an excerpt from the College of Engineering's statement on Ethics, Professionalism, and Conduct of Engineering Students. The notes are modifications appropriate for Computer Science and Engineering courses. Read the statement carefully, sign it, and return it to your instructor Additional copies of this statement can be obtained from the course web page.

Statement on Ethics, Professionalism, and Conduct of Engineering Students
College of Engineering
The University of Texas at Arlington

The College cannot and will not tolerate any form of academic dishonesty by its students. This includes, but is not limited to 1) cheating on examination, 2) plagiarism, or 3) collusion.

Definitions:

A. **Cheating on an examination** includes:

1. Copying from another's paper, any means of communication with another during an examination, giving aid to or receiving aid from another during an examination;
2. Using any material during an examination that is unauthorized by the proctor;
3. Taking or attempting to take an examination for another student or allowing another student to take or attempt to take an examination for oneself.
4. Using, obtaining, or attempting to obtain by any means the whole or any part of an unadministered examination.

B. **Plagiarism** is the unacknowledged incorporation of another's work into work which the student offers for credit.
C. **Collusion** is the unauthorized collaboration of another in preparing work that a student offers for credit.
D. Other types of **academic dishonesty** include using other student's printouts from the ACS labs or students' disk, etc.

1. The use of the source code of another person's program, even temporarily, is considered **plagiarism**.
2. Allowing another person to use your source code, even temporarily, is considered **collusion**.
3. Use of another person's source code with your modification is considered **plagiarism.**
4. Taking material verbatim (without quoting the source) for reports and/or presentations is considered **plagiarism**
5. For this class, the specific exceptions given below are not considered scholastically dishonest acts:
   Discussion of the algorithm and general programming techniques used to solve a problem

The penalty assessed for cheating on a given assignment will be the entire weight of the assignment and will include notification of the proper authorities as stipulated in the **UTA Handbook of Operating Procedures** and on the web at *http://www2.uta.edu/discipline*

You may be entitled to know what information UT Arlington (UTA) collects concerning you. You may review and have UTA correct this information according to procedures set forth in UT System BPM #32. The law is found in sections 552.021, 552.023 and 559.004 of the Texas Government Code.

I have read and I understand the above statement.

Student's signature: _____

Student's name (printed): _____

Student's ID number: _____