CSE 5311-001: ADVANCED ALGORITHMS

Summer 2011: MW 3:30 p.m. - 5:20 p.m., ERB 130

Instructor: Bob Weems, Associate Professor
Office: 627 ERB (weems@uta.edu, http://ranger.uta.edu/~weems)
Hours: M 11:00 a.m. - 12:45 p.m., W 5:30 - 6:30 p.m.

GTA:
Office:
Email:
Hours:

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*, *3rd ed*., MIT Press, 2009. (Henceforth known as CLRS)

References:

S. Baase and A. Van Gelder, *Computer Algorithms, Introduction to Design and Analysis*, *3rd ed*., Addison-Wesley, 2000.

M. de Berg et.al., *Computational Geometry: Algorithms and Applications, 3rd ed*., Springer-Verlag, 2010.

A. Borodin and R. El-Yaniv, *Online Computation and Competitive Analysis*, Cambridge Univ. Press, 1998.

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

E.D. Demaine and J. O'Rourke, *Geometric Folding Algorithms: Linkages, Origami, Polyhedra*, Cambridge Univ. Press, 2007.

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 Univ. Press, 1997.

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 Java*, *Parts 1-5, 3rd ed.*, Addison-Wesley, 2003.

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 15, 3:30 p.m. - 5:30 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 3:15 p.m.. After the due date neither I, nor the GTA, 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. If you require a reasonable accomodation for a disability, please contact me no later than the second week of this semester. Further details are available at `http://www.uta.edu/disability`.

9. Occasional class-wide email messages (e.g. weather situations, clarifications) may be sent to the addresses recorded by MyMav. These will also be archived on the course web page.

Course Outline

Starred (*) topics are not in CLRS

1. Mathematical Preliminaries
   - Recurrences - Master Method (4.5-4.6.1)
   - Probability and Randomized Algorithms (5)
2. Binary Search Trees
   - Red-Black Trees - Review (13)
   - AVL Trees*
   - Treaps (problem 13-4)
   - Augmenting Data Structures (14)
3. Amortized Analysis (17)
4. Self-Organizing Linear Search (Computing Surveys*, problem 17-5)
5. Trees

- Optimal Binary Search Trees (15.5)
- Self-Adjusting Binary Search Trees (Splay trees/amortized analysis) (JACM)*

6. Skip Lists*
7.a. Priority Queues - Review (6.5)
- Binary Trees, Binary Heaps, d-heaps*, Leftist Heaps*
- Binomial Heaps (problem 19-2)
- Fibonacci Heaps (19)

7.b. van Emde Boas Trees (20)
8. Disjoint Sets (union-find trees) (21)
9. Hashing
- Review (11.2-11.4)
- Brent's Rehash*, Cuckoo Hashing*
- Perfect Hashing (11.5)
- Optimal Hashing*
- Bloom Filters*

10. Medians/Selection (9.3)
11. Minimum Spanning Trees (23)
- Brief review of Prim
- Review of Kruskal's Algorithm 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*

18. Intractability (34, 35)
- Sample Intractable Problems
- Complexity Classes
- Reductions
- Polynomial-Time Approximation

16. Matrices
- Strassen's Matrix Multiplication (4.2)
- Binary Matrix Multiplication and Four Russians Trick*

17. Computational Geometry (33)
- Fundamental Predicates
- Closest Pairs
- Convex Hulls
- Sweepline Algorithms

15. Sequences
- Pattern Preprocessing Search
  - Rabin-Karp Algorithm (32.2)
  - Gusfield's Z Algorithm*
  - Knuth-Morris-Pratt Algorithm (32.4)
- Text Preprocessing - Suffix Arrays*
- Longest Common Subsequences
  - Dynamic Programming - Review and Linear Space* Version
  - Four Russians for LCS*
  - Longest Strictly Increasing Subsequence Approach*

TEST 2

Calendar - with subject numbers from course content

June				July/August			
6	Syllabus/1.	8		4	No Class	6	9./10
13	2.	15	3./4.	11	11.	13	12.
20	5.	22	6./7.	18	Exam 1	20	18.
27		29	8.	25		27	
				1	16.	3	17.
				8	15.	10	
				15	Exam 2		

Thursday, July 21 is the last day to withdraw.

Statement of Ethics - Student Confirmation

(CSE 5311, Summer 2011)

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 OIT labs or students' stick, 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: _____