CSE 5311-001 (Advanced Algorithms) SYLLABUS

Fall 2002: T R 2:00-3:20, Geoscience Hall 104

Instructor: Bob Weems, Associate Professor (weems@uta.edu, http://reptar.uta.edu)
Office: 344 Nedderman, 817/272-2337
Hours: T R 3:30-5:00
GTA: Yongsheng Bai (yxb4544@omega.uta.edu)

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

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

Goals:
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.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-Complete Problems*, PWS, 1997.

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

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

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

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

R. Sedgewick, *Algorithms, 2nd ed.*, Addison-Wesley, 1988.

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.

Exams: 2 exams, weighted equally. Each exam will be 50% closed notes, 50% open notes

Homework: Two assignments - NOT GRADED.

Project: A project should highlight a particular algorithm, but should also present the context (e.g. other algorithms). Implementation is not required, but could be useful in gaining insight. Some tired (or trivial) topics (e.g sequential sorting, convex hulls, FFT, traveling salesperson, LZ compression, elementary RSA cryptography, file structures from CSE 5330/5331) will NOT be acceptable. Likewise, be careful in pursuing topics outside of the ''bounds'' of the terms that appear in the index of CLRS. (For example, genetic algorithms, neural computing, cache-coherence policies, network protocols, database join techniques, error-correcting codes, and computer chess-playing techniques are NOT appropriate.) Besides the write-up (nominally 15 pages), each student must give a 10-minute presentation (i.e. enough time for one example) on November 26 (11:00-3:20), December 3 (11:00-3:20), or December 5 (11:00-3:20).

Milestone	Due Date	Weight
Topic	Oct 17	10%
Revised Topic	Oct 31	15%
Presentation	Nov 26 Dec 3, 5	25%
Paper	December 5	50%

A topic submission will include 1) a list of resources, 2) a narrative explaining what you will do, and 3) copies of the primary resources (unless available on-line). At least one of your primary resources must be from the last two years. If the Oct 17 topic submission is appropriate, along with being sufficiently detailed and supported, then the revision is just a technicality.

Recent books, conference proceedings (e.g. IEEE Foundations of Computer Science) or journals (*J.ACM, SIAM J. on Computing, Information Processing Letters*) or Springer-Verlag's extensive *Lecture Notes in Computer Science* will be useful resources in developing a topic. Time spent finding a good topic will reap benefits later . . .

I WILL NOT PROVIDE ASSISTANCE TO THOSE WHO HAVE NOT ALREADY TRIED ON THEIR OWN! EXPECT TO SPEND A SATURDAY (LIBRARY/WEB) FINDING A TOPIC.

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

Exams:	70% (Test 2: Tuesday, December 10, 2:00-4:30 pm)
Labs:	10% (Two labs, equal weight)
Project:	20%

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. A due date will be given for each homework. On the due date the solutions will be available from the web page. The GTA will assist with homework questions.

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. Failure to sign the statement will result in 1) programming assignments to not be accepted, i.e. late penalty 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 lab/project documents are penalized 30% per day. 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 or *one* of the project documents. To use your extension you must send an email to the grader *before* 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 `yxb4544@omega.uta.edu` by Tuesday, September 3:

   a. Name.
   b. Last four digits of UTA student id.
   c. Additional email addresses.
   d. Special circumstances affecting your performance.
   e. Class time conflicts (for doing presentation).
   f. What books were used in your previous course(s) in algorithms and data structures?
   g. (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. Selective Review and Extensions of Data Structures
    - AVL Trees*
    - Red-Black Trees - Review (13)
    - Augmenting Data Structures (14)
    - Amortized Analysis (17)
    - Self-Organizing Linear Search (Computing Surveys)*
    - Optimal Binary Search Trees (15.5)
    - Skip Lists*
    - Self-Adjusting Binary Search Trees (Splay trees/amortized analysis) (JACM)*
    - Priority Queues - Review (6.5)
    - Binomial Heaps (19)
    - Fibonacci Heaps (20)
    - Disjoint Sets (union-find trees) (21)
    - Hashing - Brent's Rehash*, Perfect Hashing (11.5)
3. Medians/Selection (9.3)
4. Graph Algorithms
    - Minimum Spanning Trees (23)
        - Brief review of Prim
        - Kruskal's Algorithm (application of union-find trees)

TEST 1

    - Max-Flow/Bipartite Matching (26)
        - Brief review of Ford-Fulkerson
        - Preflow-push methods
        - Vertex and edge connectivity
    - Depth-First Search (22.3)
        - Biconnected Components
5. Stable Marriages* - Sedgewick handout, stable marriage lattice/rotations
   Introduction to stable roommates
6. String Matching
    - Gusfield's Z Algorithm
    - Knuth-Morris-Pratt Algorithm (32.4)
    - Rabin-Karp Algorithm (32.2)
    - Suffix Trees and Suffix Arrays
7. Matrices
    - Strassen's Matrix Multiplication (28.2)
    - LUP decomposition (28.3)
8. Computational Geometry (33)
9. Intractability (34, 35)
    - Sample Intractable Problems
    - Complexity Classes
    - Reductions
    - Polynomial-Time Approximation

TEST 2

Calendar/Topics

August/September				October			
27	Syllabus	29	1.	1	4.	3	
3		5	2.	8		10	5.
10		12		15		17	Test 1
17		19		22	6.	24	
24		26	3.	29		31	

November				December			
5	7.	7	8.	3	Projects	5	Projects
12		14	9.	10	Test 2		
19		21					
26	Projects	28	HOLIDAY				

November 15 is the last day to withdraw.