CSCE 4133/5133: Algorithms

Catalog Description:

The senior/graduate-level course surveys important classes of algorithms used in computer science and engineering. It introduces formal techniques for analyzing the complexity and computability of algorithms. It also studies and analyzes some commonly-used data structures and algorithms, with primary emphasis on the development of efficient implementation. The course covers them in considerable depth and discusses engineering issues with a careful explanation on the mathematical proof.

Prerequisites:

- For undergrads: CSCE 3193 Programming Paradigms (C or higher) **and** MATH 2603 Discrete Math (C or higher)
- For graduates: A BS degree in Electrical Engineering, Computer Engineering, Computer Science or equivalent majors

Textbook:

The following textbook is required for this course:

- Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, The MIT Press, 3rd edition, 2009, ISBN 978-0262033848

In addition, course notes for all lectures will be used. The following books are also recommended:

- Algorithms, Robert Sedgewick and Kevin Wayne, Addison-Wesley Professional, 4th edition, 2010, ISBN 978-0321573513
- The Art of Computer Programming, Vol. 1: Fundamental Algorithms, Donald E. Knuth, Addison-Wesley Professional; 3rd edition, 1997, ISBN 978-0201896831

Course Goal:

- Analyze the complexity and performance of algorithms
- Familiarize with major algorithms and data structures
- Apply important algorithmic design paradigms and methods of analysis
- Synthesize efficient algorithms in common engineering design situations

Student Learning Outcomes. By the end of this course, students will be able to:

- Use key mathematical definitions and notations used for analyzing the time and space costs of algorithms;
- Design and implement several fundamental algorithms for data processing;
- Describe basic concepts and algorithms used in graph theory;

- Apply the four major algorithm design techniques: greedy algorithms, divide and conquer algorithms, dynamic programming, and network flow;
- Explain computational intractability results related to the class of NP-complete problems.

Topics Covered:

- Getting Started (Chapter 2)
- Growth of Functions (Chapter 3)
- Recurrences (Chapter 4)
- Heapsort (Chapter 6)
- Quicksort (Chapter 7)
- Sorting in Linear Time (Chapter 8)
- Hash Tables (Chapter 11)
- Binary Search Trees (Chapter 12)
- Red-Black Trees (Chapter 13)
- Dynamic Programming (Chapter 15)
- Greedy Algorithms (Chapter 16)
- Elementary Graph Algorithms (Chapter 22)
- Minimum Spanning Trees (Chapter 23)
- Single-Source Shortest Paths (Chapter 24)
- All-Pairs Shortest Paths (Chapter 25)
- Maximum Flow (Chapter 26)
- String Matching (Chapter 32)

Class Schedule:

Meets either 3 times a week for 50 minutes or 2 times a week for 1 hour 20 minutes for 15 weeks.

Course Website:

You must check these websites on a regular basis for most up-to-date information!

- Main Website:
  - Including course materials, grades, and reports
  - https://e3da.csce.uark.edu/teaching/CSCE5313
- Blackboard:
  - Used for announcement and assignment submission
  - Make sure to turn on email notifications
  - https://learn.uark.edu/
- Piazza Q&A Forum:
  - Used for FAQs and Student discussion
  - https://piazza.com/class/CSCE5313

Homework Assignments:

Homework will be assigned. There will be programming assignments to practice algorithm designs.

Grading:

Attendance and Participation: 10%
Homework or Programming Assignments: 30%
Two Midterm Exams: 30%
Final Exam: 30%

Grading will be regularly updated on the course website. It's your responsibility to check and report if the posted grades are incorrect.

Only exam grades may be curved. Graduate students may have a higher quality requirement standard. We will use the following scale to assign final grades:

A: [90, 100] B: [80, 90), C: [70, 80), D: [60, 70), F: below 60%

Absences:

You must notify the instructor via email if you are not able to attend a test or will be late with an assignment. You are to notify the instructor **before** the test or assignment due date if at all possible. Excused absences are allowed with a **written** record for illness, death of a family member, and other reasonable emergencies. For student sickness, you can use the course absence form after visiting a doctor or Pat Walker Health Center: http://e3da.csce.uark.edu/teaching/download/class_absence.pdf

Academic Honesty:

As a core part of its mission, the University of Arkansas provides students with the opportunity to further their educational goals through programs of study and research in an environment that promotes freedom of inquiry and academic responsibility. Accomplishing this mission is only possible when intellectual honesty and individual integrity prevail.

Each University of Arkansas student is required to be familiar with and abide by the University's 'Academic Integrity Policy' which may be found at honesty.uark.edu/policy. Students with questions about how these policies apply to a particular course or assignment should immediately contact their instructor.

Emergency Preparedness:

Many types of emergencies can occur on campus; instructions for specific emergencies such as severe weather, active shooter, or fire can be found at emergency.uark.edu. The University of Arkansas has a campus-wide alert system for any hazardous conditions that may arise on campus. To learn more and to sign up: http://safety.uark.edu/emergency-preparedness/emergency-notification-system/

Inclement Weather:

If the university is officially closed, class will not be held. When the university is open, you are expected to make a reasonable effort to attend class, but not if you do not feel that you can get to campus safely. Any changes to due dates or the class schedule will be communicated via email to your uark email address.

Academic Support:

University of Arkansas Academic Policy Series 1520.10 requires that students with disabilities are provided reasonable accommodations to ensure their equal access to course content. If you have a documented disability and require accommodations, please contact me privately at the beginning of the semester to make arrangements for necessary classroom adjustments. Please note, you must first verify your eligibility for these through the Center for Educational Access (contact 479–575–3104 or visit http://cea.uark.edu for more information on registration procedures).

Relationship of course to ABET Computer Engineering Student Outcomes:

- CE1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- CE7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Relationship of course to ABET Computer Science Program Student Outcomes:

- CS1. An ability to analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
- CS2. An ability to design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
- CS6. An ability to apply computer science theory and software development fundamentals to produce computing-based solutions.

Relationship of course to ABET Computer Science Topics:

- T4. Substantial coverage of algorithms and complexity, computer science theory, concepts of programming languages, and software development.