LEARNING ABROAD CENTER
UNIVERSITY OF MINNESOTA

In Partnership With

FOM
FUNDACIÓN JOSÉ ORTEGA Y GASSET - GREGORIO MARAÑÓN

Algorithms & Data Structures

Course Details

Course Designator & Number: MADR 4041
Number of Credits: 4
Language of Instruction: English
Contact Hours: 60
Instructor: Onsite Faculty

Course Description

Rigorous analysis of algorithms/implementation. Algorithm analysis, sorting algorithms, binary trees, heaps, priority queues, heapsort, balanced binary search trees, AVL trees, hash tables and hashing, graphs, graph traversal, single source shortest path, minimum cost spanning trees.

This is a required course for computer science and computer engineering majors, usually taken in the junior year. It is also a useful course for other students who desire to learn some core material in computing. It covers important data structures and algorithms, as well as analysis of algorithms, and algorithm paradigms such as greedy algorithms and divide-and-conquer.

It is 4 credits, with 3 hours/week in lecture, and 1 hour/week in discussion. Discussion can be used for problem solving and review, or more in-depth discussion of topics and examples given in lecture. Since many students struggle with topics like analyzing algorithms, identifying what algorithms/data structures are appropriate to use in given situations, etc., the practice given in discussion can be valuable.

Course Objectives

For each of the data structures (e.g., graphs) or concepts (e.g., time complexity) discussed in class, the student should be able to:

a. define the basic terminology and use it correctly;

    b. give an explanation of why it is important, and provide and discuss specific examples of its use;
    c. identify its important characteristics, as well as any variants or special cases;
    d. perform the basic operations associated with it;
    e. use it, when applicable, to analyze and solve problems.
2. For each of the algorithms discussed in class, the student should be able to:
    a. explain the algorithm's purpose, key steps, major characteristics, and what types of problems it's applicable to;
    b. given input, be able to trace through the workings of the algorithm;
    c. analyze the characteristics of a given algorithm, including time and space complexity;
    d. determine correctness of a purported algorithm.
3. Students should also have the following additional analysis, problem solving, and presentation skills. Given a problem, students should be able to:
    a. identify which structures, algorithms, and/or techniques could be useful in analyzing or solving the problem, and why;
    b. modify or specialize structures, algorithms, or techniques to make them applicable to problems that are not amenable to straightforward use of the structure, algorithms. or techniques;
    c. construct an algorithm (including appropriate data structures, if needed), to solve the given problem;
    d. be able to write code to implement a solution algorithm;
    e. tell whether a purported solution or analysis is correct;
    f. present analysis and solutions precisely, accurately, rigorously, and informatively.

Course Prerequisites

CSci 4041 has 1913/1933 (CS II) and 2011 (Discrete Structures) as prerequisites. In 1913/1933 students learn fundamental data structures (lists, stacks, queues, dictionaries, and hash tables) and some basic algorithms such as searching and sorting algorithms. In CSCI 2011 (Discreet Structures) students have an introductory familiarity with topics such as proof techniques, big-O notation, and sets and graphs. 4041 builds on this knowledge, exploring more advanced algorithms, data structures, and algorithm analysis.

Why This Class Is Important

Familiarity with algorithms and data structures, and the ability to use them to analyze problems and to implement solutions, is crucial in many computer science applications.

Required Reading / Materials

Probable Text

Introduction to Algorithms, Thomas Cormen, Charles Leiserson, and Ronald Rivest.

Communication Skills

Students should be able to describe data structures and algorithms accurately, precisely, rigorously, and informatively. This includes skills such as being able to draw informative diagrams of data structures, being able to state and rigorously prove the time complexity of a given algorithm, and being able to correctly and precisely present an algorithm using pseudocode. These communication skills are important in professional communication.

Grading

Grading Rubric

Letter Grade	Score or Percentage	Description
A	93–100	Achievement that is outstanding relative to the level necessary to meet course requirements.
A-	90–92	Achievement that is significantly above the level necessary to meet course requirements.
B+	87–89	
B	83–86	
B-	80–82	Achievement that meets the course requirements in every respect.
C+	77–79	
C	73–76	
C-	70–72	Achievement that is worthy of credit even though it fails to fully meet the course requirements.
D+	67–69	
D	60–66	
F	0–59	Represents failure (or no credit) and signifies that the work was either (1) completed but at a level of achievement that is not worthy of credit or (2) was not completed and there was no agreement between the instructor and the student that the student would be awarded an I.

Sample Course Schedule

Unit 1

- Introduction and Review (stacks, lists, and other basic data structures; searching, sorting and other basic algorithms; big-O)

Unit 2

- Introduction and Review (stacks, lists, and other basic data structures; searching, sorting and other basic algorithms; big-O)

Unit 3

- Algorithm Analysis (big-O, big-Θ, big-Ω; best case, worst case, and average case; time and space complexity)

Unit 4

- Sorting (more advanced sorting algorithms and analysis)

Unit 5

- Trees (including topics such as balanced trees, tree applications, and types of trees such as AVL trees and splay trees)

Unit 6

- Trees (including topics such as balanced trees, tree applications, and types of trees such as AVL trees and splay trees)

Unit 7

- Greedy Algorithms

Unit 8

- Divide-and-Conquer and Recursive Algorithms

Unit 9

- Dynamic Programming

Unit 10

- Graphs (review, traversal, minimal cost spanning trees, etc.)

Unit 11

- Graphs (review, traversal, minimal cost spanning trees, etc.)

Unit 12

- Additional algorithms (e.g., geometric algorithms, probabilistic algorithms, numerical algorithms), data structures, or theoretical results about algorithms

Policies

Attendance Policy

Students are expected to be on time and attend all classes while abroad. Many instructors assess both attendance and participation when assigning a final course grade. Attendance alone does not guarantee a positive participation grade; the student should be prepared for class and engage in class discussion. See the on-site syllabus for specific class requirements.

University of Minnesota Policies & Procedures

Academic integrity is essential to a positive teaching and learning environment. All students enrolled in University courses are expected to complete coursework responsibilities with fairness and honesty. Failure to do so by seeking unfair advantage over others or misrepresenting someone else's work as your own can result in disciplinary action. The University Student Conduct Code defines scholastic dishonesty as follows:

Scholastic Dishonesty

Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis.

Within this course, a student responsible for scholastic dishonesty can be assigned a penalty up to and including an "F" or "N" for the course. If you have any questions regarding the expectations for a specific assignment or exam, ask.

Student Conduct

The University of Minnesota has specific policies concerning student conduct. This information can be found on the Learning Abroad Center website.