Master Course Syllabus

For additional course information, including prerequisites, corequisites, and course fees, please refer to the Catalog: https://catalog.uvu.edu/

Semester: Spring
Year: 2025
Course Prefix: CS
Course and Section #: 3310-002
Course Title: Analysis of Algorithms
Credits: 3

Course Description

Develops and reinforces ability to write and mathematically analyze foundational computer algorithms. Includes formalizing NP-completeness, divide and conquer strategies, greedy algorithms, dynamic programming, backtracking, branch and bound, approximation algorithms and multicore parallelization.

Lab access fee of $45 for computers applies.

Course Attributes

This course has the following attributes:

☐ General Education Requirements
☐ Global/Intercultural Graduation Requirements
☐ Writing Enriched Graduation Requirements
☒ Discipline Core Requirements in Program
☒ Elective Core Requirements in Program
☐ Open Elective

Other: *Click here to enter text.*

Instructor Information

Instructor Name: Nathan Cordner

Student Learning Outcomes

Upon successful completion, students should be able to . . .

1 Calculate the Big-O complexity of an algorithm.
2 Classify problems that embed strategies like divide and conquer, branch and bound, and parallelism according to Big-O complexity.
3 Summarize intractability and its impact on computation.
4 Write sequential and multicore parallel versions of algorithms.
5 Benchmark sequential and multicore parallel versions of algorithms.

Course Materials and Texts

Algorithms Illuminated, Omnibus Edition, by Tim Roughgarden

Course Requirements

Course Assignments, Assessments, and Grading Policy

Course Work

Attendance

Class attendance is the expectation for a face-to-face section. For full credit, you must attend at least **90%** of the lectures (no more than 3 classes missed). Your grade will be determined by the percentage of lectures that you do attend (total of 27 possible this semester) out of the total number required (24 this semester). Half-credit may be given for attending part of a class while missing significant portions of the class discussion. No credit will be given for attending without being engaged in class discussion.

Please come see me if there are extenuating circumstances that prevent your attendance for prolonged periods during the semester. **Students who are unable to come to campus at all during class time and are hoping to participate remotely need to make arrangements with me.**

Warm-up Exercises

A short written exercise will be given at the end of every lecture to serve as the start of the discussion for the next class meeting. These will be posted on Canvas, and will be due at the start of every class. Grading will be based on demonstrating your thought process rather than on correctness. **Responses must reflect your own work for full credit**.

Presentations

Starting on the second day of class, two or three students will be chosen randomly to give short presentations during the lecture. One student will present their solution to the warm-up exercise. The other presentations will be based on the current lecture topic, such as showing applications of a problem we're discussing or summarizing a proof from the textbook (the specific topics will be provided before each class). Each student is expected to be prepared to present if called upon.

Grading will be based on preparation and participation (e.g. you do not need to have solved the warm-up exercise correctly, but you do need to have attempted the problem and be able to explain your thought process for the solution you arrived at). Declining to present, or presenting without being prepared will result in a deduction to your grade (10% after first decline, 30% after the second, and no credit after the third; presenting without proper preparation will receive at most half credit).

Based on a class size of 30 people, each student can expect to present up to 3 times during the semester.

Homework

There will be 12 regular homework assignments. Each is worth 5 points, and will contain a mix of written and programming problems. Working with other students is allowed, but you must turn in your own solutions (not ChatGPT's). For programming problems, any language is allowed (though Python is preferred).

Final Project

At the end of the semester you will join a group and conduct research into an interesting NP-hard problem of your choice. You will give a presentation where you discuss the problem along with various algorithms that have been developed as attempts to (approximately) solve the hard problem. You will not be allowed to present on a problem that has already been discussed in class. Fortunately, there are many, many hard problems out there!

The last two homework assignments (Final Project parts 1 and 2) will be related to completing this project.

Extra Credit

There will be a few opportunities for extra credit during the semester, primarily from filling out a mid-course feedback survey and the end-of-semester SRI.

Time Commitment

You should expect to spend about 1 - 2 hours preparing for each lecture, and about 2 - 4 hours per week on the homework. This translates to a rough time commitment of 4 - 8 hours per week for 3310, depending on your level of preparation. Please come talk to me if you find yourself regularly exceeding these estimates.

Grading
The final grade is broken down into the following categories
Assignments -- 60% of the total

- Homework: 45% of the total
- Final Project: 15% of the total

Participation -- 40% of the total

- Attendance: 15% of the total
- Warm-ups: 10% of the total
- Presentations: 15% of the total

Letter grades are assigned using the following table

Grade	Minimum Percent
A	93
A-	90
B+	87
B	83
B-	80
C+	77
C	73
C-	70
D+	67
D	63
D-	60
E	0

Late Submission
Homework assignments will be sent out by Wednesday each week, and will be due by the end of the following Tuesday. Assignments will remain open until the end of the Friday following the due date fora roughly 10% deduction per day late (divided into hourly increments). Those wishing to make up homework assignments after the close date will need to come see me.
No late submissions are allowed for missed warm-up exercises.
Extensions: One to two day extensions will usually be granted, if applied for *before* the due date. Send me a message, tell me your progress on the assignment so far, and let me know how much more time you need. No late penalty. Penalty-free extensions beyond the assignment close date will rarely be granted.
Redemption: I will allow you to earn back points on lost on homework assignments, up to half of what was missed (not including late penalties). For example, if you got 3 out of 5 on a homework then you can get a total of 1 point back. To qualify you must have attempted the problem and turned it in before the close date. You will need to show your understanding of the problem, why your solution was incorrect, how you fixed it, etc. Please do this within two weeks of receiving your grade for a particular assignment.

Required or Recommended Reading Assignments
Lecture Schedule
Subject to change as the semester progresses

Date	**Topic**	**Readings**	**Assignments**
6 January	Introduction (**class will not meet; see posted video**)	1.1, Appendix A	
8 January	Multiplication Algorithms	1.2, 1.3	
13 January	Big-O Notation	1.6, 2.1 to 2.5	Homework 1 Due (Tuesday)
15 January	Divide and Conquer	1.4, 1.5, 3.1, 3.2	
20 January	**Martin Luther King Jr. Day**		Homework 2 Due (Tuesday)
22 January	The Master Method	4.1 to 4.4	
27 January	QuickSort	5.1 to 5.5, Appendix B	Homework 3 Due (Tuesday)
29 January	Linear-Time Selection	6.1 to 6.4	
3 February	Graphs and Hash Tables	7.1 to 7.4, 12.1, 12.2 (12.3, 12.4 optional)	Homework 4 Due (Tuesday)
5 February	Graph Search (BFS and DFS)	8.1 to 8.4	
10 February	Topological Sort	8.5	Homework 5 Due (Tuesday)

12 February	Strongly Connected Components	8.6, 8.7	
17 February	**President's Day**		Homework 6 Due (Tuesday)
19 February	Dijkstra's Algorithm	9.1 to 9.4	
24 February	Dijkstra Improvements	10.1 to 10.5	Homework 7 Due (Tuesday)
26 February	Greedy Algorithms	13.1 to 13.4	
3 March	Minimum Spanning Trees	15.1 to 15.3, 15.5	Homework 8 Due (Tuesday)
5 March	Minimum Spanning Trees	15.4, 15.6 to 15.8	
10 March	**Spring Break**		
12 March	**Spring Break**		
17 March	Dynamic Programming Intro	16.1 to 16.4	Homework 9 Due (Tuesday)
19 March	Knapsack	16.5	
24 March	Sequence Alignment	17.1	Homework 10 Due (Tuesday)
26 March	Generalized Shortest Paths	18.1 to 18.4	
31 March	NP Intro, Travelling Salesman Problem	19.1 to 19.4, 21.1	Homework 11 Due (Tuesday)
2 April	Reductions	19.5, 19.6, 22.1 to 22.4	
7 April	Reductions	22.5 to 22.8	
9 April	Makespan Minimization	20.1	**Homework 12 Due (Friday)**
14 April	Maximum Coverage and Influence Maximization	20.2, 20.3	Final Project Part 1 Due (Tuesday)
16 April	Local Search and the TSP	20.4, 20.5	

21 April	Clustering	See Warm-up Assignment	Final Project Part 2 Due (Tuesday)
28 April	**Final Project Presentations**		Rest of Final Project Due

General Description of the Subject Matter of Each Lecture or Discussion

1. Introduction – overview of course and policies
2. Multiplication Algorithms – initial discussion of multiplication, including recursive and Karatsuba multiplication
3. Big-O Notation – introduction to asymptotic notation and analysis
4. Divide and Conquer – discussion of MergeSort and applications to inversion counting
5. The Master Method – discussion of time complexity for recursive algorithms
6. QuickSort – discusses algorithm and covers average-case time complexity analysis
7. Linear-Time Selection – application of QuickSort technique to find medians in linear time
8. Graphs and Hash Tables – review of data structures needed to discuss graph algorithms
9. Graph Search – introduction to BFS and DFS algorithms
10. Topological Sort – apply DFS to find topological orders in DAGs
11. Strongly Connected Components – discussion of Kosaraju's algorithm to find SCCs in general graphs
12. Dijsktra's algorithm – introduction to single-source shortest path problem and Dijkstra's method
13. Dijkstra improvements – algorithm speed-up using heaps
14. Greedy Algorithms – introduction to greedy method and job scheduling problems
15. Minimum Spanning Trees (part 1) – introduces MSTs, and Prim's and Kruskal's algorithms
16. Minimum Spanning Trees (part 2) – analysis of correctness, and union-find data structure for Kruskal
17. Dynamic Programming Intro – overview of DP technique, introduces maximum weighted independent sets on path graphs
18. Knapsack – overview of DP algorithm for knapsack
19. Sequence Alignment – overview of DP algorithm for edit distance, and generalizations
20. Generalized Shortest Paths – overview of Bellman-Ford, Floyd-Warshall DP algorithms
21. NP Intro, TSP – introduction to complexity classes, discussion of hard problems, Bellman-Held-Karp DP algorithm for TSP
22. Reductions (part 1) – formal definition of NP-hardness, initial discussion of using reductions to demonstrate hardness, introduction to Cook-Levin theorem
23. Reductions (part 2) – more examples of reductions to show NP-hardness
24. Makespan Minimization – example of NP-hard problem, introduces approximation algorithms
25. Maximum Coverage and Influence Maximization – more examples of NP-hard problems and approximation algorithms
26. Local Search and TSP – introduces idea of Local Search for optimization, covers 2-change algorithm for TSP
27. Clustering – overview of clustering algorithms, including K-Means

Required Course Syllabus Statements

Generative AI
Students should use AI tools like ChatGPT as if it were a person. If asking another person to do task X is cheating, then asking ChatGPT and similar tools is cheating. If not, then not.

Using Remote Testing Software
☒ This course does not use remote testing software.

☐ This course uses remote testing software. Remote test-takers may choose their remote testing locations. Please note, however, that the testing software used for this may conduct a brief scan of remote test-takers' immediate surroundings, may require use of a webcam while taking an exam, may require the microphone be on while taking an exam, or may require other practices to confirm academic honesty. Test-takers therefore shall have no expectation of privacy in their test-taking location during, or immediately preceding, remote testing. If a student strongly objects to using test-taking software, the student should contact the instructor at the beginning of the semester to determine whether alternative testing arrangements are feasible. Alternatives are not guaranteed.

Required University Syllabus Statements

Accommodations/Students with Disabilities
Students needing accommodations due to a permanent or temporary disability, pregnancy or pregnancy-related conditions may contact UVU Accessibility Services at accessibilityservices@uvu.edu or 801-863-8747.

Accessibility Services is located on the Orem Campus in BA 110.

Deaf/Hard of Hearing students requesting ASL interpreters or transcribers can contact Accessibility Services to set up accommodations. Deaf/Hard of Hearing services can be contacted at DHHservices@uvu.edu

DHH is located on the Orem Campus in BA 112.

Academic Integrity
At Utah Valley University, faculty and students operate in an atmosphere of mutual trust. Maintaining an atmosphere of academic integrity allows for free exchange of ideas and enables all members of the community to achieve their highest potential. Our goal is to foster an intellectual atmosphere that produces scholars of integrity and imaginative thought. In all academic work, the ideas and contributions of others must be appropriately acknowledged and UVU students are expected to produce their own original academic work.

Faculty and students share the responsibility of ensuring the honesty and fairness of the intellectual environment at UVU. Students have a responsibility to promote academic integrity at the university by not participating in or facilitating others' participation in any act of academic dishonesty. As members of the academic community, students must become familiar with their rights and responsibilities. In each course, they are responsible for knowing the requirements and restrictions regarding research and writing, assessments, collaborative work, the use of study aids, the appropriateness of assistance, and other issues. Likewise, instructors are responsible to clearly state expectations and model best practices.

Further information on what constitutes academic dishonesty is detailed in UVU Policy 541: *Student Code of Conduct*.

Equity and Title IX

Utah Valley University does not discriminate on the basis of race, color, religion, national origin, sex, sexual orientation, gender identity, gender expression, age (40 and over), disability, veteran status, pregnancy, childbirth, or pregnancy-related conditions, citizenship, genetic information, or other basis protected by applicable law, including Title IX and 34 C.F.R. Part 106, in employment, treatment, admission, access to educational programs and activities, or other University benefits or services. Inquiries about nondiscrimination at UVU may be directed to the U.S. Department of Education's Office for Civil Rights or UVU's Title IX Coordinator at 801-863-7999 – TitleIX@uvu.edu – 800 W University Pkwy, Orem, 84058, Suite BA 203.

Religious Accommodation

UVU values and acknowledges the array of worldviews, faiths, and religions represented in our student body, and as such provides supportive accommodations for students. Religious belief or conscience broadly includes religious, non-religious, theistic, or non-theistic moral or ethical beliefs as well as participation in religious holidays, observances, or activities. Accommodations may include scheduling or due-date modifications or make-up assignments for missed class work.

To seek a religious accommodation, a student must provide written notice to the instructor and the Director of Accessibility Services at accessibilityservices@uvu.edu. If the accommodation relates to a scheduling conflict, the notice should include the date, time, and brief description of the difficulty posed by the conflict. Such requests should be made as soon as the student is aware of the prospective scheduling conflict.

While religious expression is welcome throughout campus, UVU also has a specially dedicated space for meditation, prayer, reflection, or other forms of religious expression.