**Advanced algorithms**

**Course Name:** Advanced algorithms

**Course Number:** Cpt S 515

**Credits:** 3

**Lecture Hours:** 3

**Schedule:** Offered online (asynchronously) via Global Campus

**Prerequisites:** Graduate standing.

**Course required/elective:** required.

**Professors/Coordinators:** Zhe Dang.

**Required textbook(s):**

[1] Cormen, Thomas H.; Leiserson, Charles E.; Rivest, Ronald L.; Stein, Clifford (2009). Introduction to Algorithms (3rd ed.). MIT Press and McGraw-Hill.[[1]](#footnote-1)

**Course description:** Advanced algorithms, randomized algorithms, Hashing, approximation algorithms.

**Overview and Course Goals:** This course will provide graduate students with a solid background on modern algorithms. It will first introduce fundamentals of algorithms (e.g., Turing model, complexity) and then explore advanced algorithms for modern computer science in areas such as big data and software engineering.

**Course topics and the corresponding program learning outcomes**[[2]](#footnote-2)**:**

- Fundamentals of algorithms [2]

- Basic algorithms [2]

- Advanced algorithms [2]

- NP-completeness [2]

**Learning outcomes:**

Students that successfully complete the course will be able to:

1. Understand the design and analysis principles in modern advanced algorithms and apply the algorithms in solving some computer science problems. This is a central skill for all computer science graduate students and is a key for them to be successful in their research. This outcome is addressed by all the topics throughout the semester. This outcome is evaluated primarily by all the homeworks and the exams.

2. Understand the theory foundation of intractability. Many graduate computer science students still think efficient algorithms can always be designed if they are smart or skillful enough. However, theoretically, most problems do not even have efficient algorithms to solve. This outcome will rigorously clear a common misunderstanding about algorithms. This outcome is addressed by topics in weeks 12, 13, 15. This outcome is evaluated primarily by the final exam.

Mapping student learning outcomes, course topics, and evaluations:

|  |  |  |
| --- | --- | --- |
| Student Learning Outcomes | Course topics/dates | Evaluation of Outcome |
| 1 | Basic algorithms, advanced algorithms (weeks 1-15) | Homeworks 1-6, mid-term exam, and final exam. |
| 2 | Algorithms completeness and approximation (weeks 12, 13, and 15) | Final exam. |

**Week-by-week schedule:**

|  |  |  |
| --- | --- | --- |
| Week | Topics | Evaluation |
| 1 | Fundamentals on algorithms: Turing model and definition of algorithms, time/space complexity, complexity analysis preliminaries: recurrence functions. |  |
| 2 | Basic algorithms: greedy, divide-conquer and dynamic programming techniques.Basic algorithms and their analysis on linear structures. | Homework 1 |
| 3 | Basic algorithms and their analysis on tree structures. Basic algorithms and their analysis on graphs. |  |
| 4 | Advanced algorithms: Network flows. | Homework 2 |
| 5 | Bipartite matching. |  |
| 6 | Linear programming. | Homework 3 |
| 7 | Symbolic graph search and formal verification of software. | Mid-term exam |
| 8 | Randomized algorithms: Random variables and their properties. |  |
| 9 | Hashing, hash functions and universal hash functions. | Homework 4 |
| 10 | Breaking MD5, Las Vegas, and Monte Carlo algorithms: examples. |  |
| 11 | Google page rank and Markov chain, How to select a random test case. | Homework 5 |
| 12 | P, NP, co-NP, PSPACE and #P. |  |
| 13 | Many-to-one reduction and NP-completeness, NP-complete problems. | Homework 6 |
| 14 | Thanksgiving break. |  |
| 15 | Approximation algorithms for some NP-complete problems. |  |
| 16 |  | Final exam |

**Grading framework:** Course grades are based on 6 homework assignments totaling 30% of the final grade and on 2 exams (one mid‐term and one final) exam totaling 70% of the final grade (30% and 40% for the mid-term and final exam, respectively).

Homework 1: Review problem for basic algorithms and their complexity.

Homework 2: Problem on non linear structure and network flow.

Homework 3: Application problems on bipartite matching and linear optimization.

Homework 4: Application of symbolic encoding and hash for software verification.

Homework 5: Test case selection on a graph.

Homework 6: NP-completeness and approximation.

Final grades will be awarded on the following scale:

Interval Grade

[90,100] A

[87,90) A‐

[83,87) B+

[80,83) B

[77,80) B‐

[73,77) C+

[70,73) C

[67,70) C‐

[63,67) D+

[60,63) D

[0,60) F

**Course rules:**

You must take exam during the assigned test period. Failure to do so will result in a score of zero. However, in extraordinary circumstances and at the discretion of the instructor, a make‐up exam may be offered. An advanced notice must be given to the instructor beforehand.

Unless posted otherwise, assignment documents shall be submitted electronically.

Late penalty is a flat 10% deduction per day. Late assignments may be turned up to one week after the original due date, and an advanced notice must be given to the instructor beforehand for the late submission. No homework will be accepted after its due day without advanced notice or special permission from the instructor.

Bonus points will be added to your total class score for attendance as follows: 0 absence = 5% of the final grade, 1 absence = 4 %, 2 absences = 3%, and 3 or more absences = 0% bonus.

**Reasonable Accommodation:**

Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center (Washington Building 217; 509-335-3417) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center.

**Academic Integrity:**

I encourage you to work with classmates on assignments. However, each student must turn in original work. No copying will be accepted. Students who violate WSU's Standards of Conduct for Students will receive an F as a final grade in this course, will not have the option to withdraw from the course and will be reported to the Office Student Conduct. Cheating is defined in the Standards for Student Conduct WAC 504-26-010 (3). It is strongly suggested that you read and understand these definitions. (Read more:<http://apps.leg.wa.gov/wac/default.aspx?cite=504-26-010>)

**Safety:**

Washington State University is committed to maintaining a safe environment for its faculty, staff, and students. Safety is the responsibility of every member of the campus community and individuals should know the appropriate actions to take when an emergency arises. In support of our commitment to the safety of the campus community the University has developed a Campus Safety Plan, <http://safetyplan.wsu.edu>. It is highly recommended that you visit this web site as well as the University emergency management web site at <http://oem.wsu.edu/> to become familiar with the information provided.

1. Available on Amazon; ISBN 0-262-03384-4. [↑](#footnote-ref-1)
2. The student learning outcomes for the MSSE program are labeled from ‘1’ to ‘4’. [↑](#footnote-ref-2)