COMPSCI 308

Design and Analysis of Algorithms

Spring 2026, Session 3

昆山杜克大学
DUKE KUNSHAN UNIVERSITY

Class meeting time: See DKU Hub.
Academic credit: 4 DKU credits.
Course format: Lectures.
Office hour: Two hours per week.
Last update: January 4, 2026

Instructor's information

Dr. Xing Shi Cai Assistant Professor of Mathematics, Duke Kunshan University

Dr. Cai received his PhD in computer science at McGill University in Canada. After that he worked as postdoc researcher at Uppsala University in Sweden. His main research interest is in applying probability theory in the analysis of algorithms and complex networks.

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What is this course about?

An **algorithm** is any well-defined computational procedure that takes some value, or set of values, as input and produces some value, or set of values, as output. An algorithm is thus a sequence of computational steps that transform the input into the output. An algorithm can also be viewed as a tool for solving a well-specified computational problem. The statement of the problem specifies in general terms the desired input/output relationship. The algorithm describes a specific computational procedure for achieving that input/output relationship.

After having a target problem, the next step is to design an algorithm that can address the target problem. **Algorithm design** is a coherent discipline-one needs a specific set of concepts to define, a computational problem and a specific set of tools to design an optimal algorithm to solve it. Designing the right algorithm for a given application is a major creative act—that of taking a problem and pulling a solution out of the ether. The space of choices you can make in algorithm design is enormous, leaving you plenty of freedom.

Solely designing algorithms may not be a proper approach to solve a specific problem. Understanding their behavioural characteristics together with their strengths and weaknesses is critical. **Algorithm analysis** is investigated for this purpose, in particular, for determining how much of a resource, such as time or memory, an algorithm uses as a function of some characteristic of the input to the algorithm, usually the size of the input.

This course will touch all the major algorithm design and analysis steps while taking data structures into account. All the relevant concepts will be exemplified through existing algorithms and problems besides implementing algorithms in Python. To be specific, the design and analysis of efficient algorithms including sorting, searching, dynamic programming, graph algorithms, nondeterministic algorithms and computationally hard problems and other related topics will be studied.

This course will be carried out in line with the DKU's animating principles. In particular, Collaborative Problem Solving, Research and Practice and Lucid Communication will be directly involved with this course while touching the Independence and Creativity aspect. The course will be primarily executed through in-class quick quizzes, in-class individual / group discussions and weekly assignments.

What background knowledge do I need before taking this course?

COMPSCI 308 has two prerequisites:

- COMPSCI 201: Introduction to Programming and Data Structures
- COMPSCI 203: Discrete Math for Computer Science or MATH 205/206: Probability and Statistics

one anti-requisite:

- COMPSCI 301: Algorithms and Databases

What will I learn in this course?

By the end of this course, you will be able to:

1. design efficient and effective algorithms of varying types
2. implement algorithms in consideration of the problem requirements and computational resources
3. utilize appropriate data structures while developing algorithms
4. introduce new algorithmic solutions for new problems
5. evaluate the theoretical boundaries of given algorithms
6. analyze the behaviour and performance of given algorithms, referring to their strengths and weaknesses
7. identify the resemblance between different problems, leading to problem hardness analysis

What will I do in this course?

Lectures

You will attend four lectures each week.

Assignment

The assignments are given in each lecture's slides. But they will not be collected or graded. The assessment is entirely based on quizzes and the final exam.

Quiz

For every two week, there are going to be one in-person closed-book quiz.

Exam

There are going to be one final exam in week 8.

How can I prepare for the class sessions to be successful?

To succeed, you should be prepared to devote several hours to this course on a daily basis. You are strongly encouraged to work with classmates, to seek information online, and to contact instructors in a timely manner for additional help as needed.

What required texts, materials, and equipment will I need?

Introduction to Algorithms (4th Ed.) by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, MIT Press, 2022 (https://mitpress.mit.edu/9780262046305/introduction-to-algorithms/)

What optional texts or resources might be helpful?

There are many useful textbooks or resources to benefit from.

- Algorithm Design (1st Ed.) by John Kleinberg and Eva Tardos, Pearson - Addison Wesley, 2005 (https://www.pearson.com/us/higher-education/program/Kleinberg-Algorithm-Design/PGM319216.html)
- Algorithms (1st Ed) by Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani, McGraw-Hill, 2006 (https://www.mheducation.com/highered/product/algorithms-dasgupta-papadimitriou/M9780073523408.html)
- Algorithms (4th Ed) by Robert Sedgewick, Kevin Wayne, Addison-Wesley, 2011 (https://algs4.cs.princeton.edu/)
- Algorithms Illuminated (Part 1): The Basics by Tim Roughgarden, Soundlikeyourself Publ, 2017 (http://www.algorithmsilluminated.org/)
- Algorithms Illuminated (Part 2): Graph Algorithms and Data Structures by Tim Roughgarden, Soundlikeyourself Publ, 2018 (http://www.algorithmsilluminated.org/)
- Algorithms Illuminated (Part 3): Greedy Algorithms and Dynamic Programming by Tim Roughgarden, Soundlikeyourself Publ, 2019 (http://www.algorithmsilluminated.org/)
- Algorithms Illuminated (Part 4): Algorithms for NP-Hard Problems by Tim Roughgarden, Soundlikeyourself Publ, 2020 (http://www.algorithmsilluminated.org/)
- Data Structures and Algorithms in Python (1st Ed) by Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Wiley, 2013 (https://www.wiley.com/en-us/Data+Structures+and+Algorithms+in+Python-p-9781118290279)
- Problem Solving with Algorithms and Data Structures using Python (2nd Ed) by Brad Miller and David Ranum, Franklin, Beedle & Associates, 2011 (*Free Book*: https://runestone.academy/runestone/books/published/pythonds/index.html)

How will my grade be determined?

Course grades will be assigned according to a standard 10-pt scale:

Grades	Percentage	C+	[77%, 80%)
A+	[98%, 100%]	C	[73%, 77%)
A	[93%, 98%)	C-	[70%, 73%)
A-	[90%, 93%)	D+	[67%, 70%)
B+	[87%, 90%)	D	[63%, 67%)
B	[83%, 87%)	D-	[60%, 63%)

Grades	Percentage	C+	[77%, 80%)
B-	[80%, 83%)	F	[0%, 60%)

💣 Points are rounded downwards, e.g., 92.99 will become to 92 (A-). Petitions for increasing grades will *not* get replies. Regrade requests will be *rejected* unless the grader misread an answer.

The course grade will be based on:

- Quizzes: 60%
- Final exam: 35%
- In-class participation: 5%

All quizzes and the exams will be closed book. Books, notes, collaborations, calculators, the Internet, and other aids are *not* allowed during exams. Cheating for the first time will result in getting zero points. Repeated infractions will cause failing the course.

Quizzes

Biweekly quizzes will be held on Mondays, beginning in Week 3.

- Each quiz covers the content from the previous two week.
- Regrade requests for objective grading errors can be submitted on GradeScope within 48 hours of grade publication.

Participation

Participation counts for up to 5% (5 points) of your final grade. You can earn up to 1 points per week for *correctly* answer a one question via Wooclap. Please log in to Wooclap via your Duke NetID.

Last-Chance Option

Students earning at least a C on the final exam are guaranteed to pass, regardless of quiz results and if you choose the NC/CR option.

Students earning an A on the final exam are guaranteed at least a C in the course.

Missing a Quiz or the Final Exam

Missed Quizzes

Missing a quiz is permitted *only* in cases of **documented, extraordinary circumstances** beyond the student's control.

- If a student misses **one** quiz for such reasons, the missed quiz score will be replaced by the **average of the other two quizzes**.
- Missing **two or more** quizzes, **for any reason**, will result in **failure of the course**.

Missed Final Exam

Missing the final exam is permitted *only* in cases of **serious and well-documented extraordinary circumstances**.

- A student who misses the final exam under such circumstances will receive an **Incomplete (I)** grade.

- The student must complete a **substitute final assessment**.

Evidence Requirement

All accommodations for missed quizzes or the final exam require **compelling, objective, and timely documentation** of illness or other extenuating circumstances.

- Documentation must clearly substantiate the student's inability to attend the assessment.
- Doctor's notes based **only** on self-reported symptoms will **not** be accepted.
- Inadequate, late, or unverifiable documentation will result in the request being denied.

What are the course policies?

Q & A

Questions *must* be posted on Ed. Emails will most likely *not* get replied.

Remote learning

If you are not able to come to classes or exams in-person, you will need to send the instructor

- the permission from the Dean of Undergraduate Studies,
- or proof of other special circumstances, such as illness.

Failing to do so will result in falling the class.

Academic Integrity

As a student, you should abide by the academic honesty standard of the Duke Kunshan University. Its Community Standard states: ''Duke Kunshan University is a community comprised of individuals from diverse cultures and backgrounds. We are dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Members of this community commit to reflecting upon and upholding these principles in all academic and non-academic endeavors, and to protecting and promoting a culture of integrity and trust.'' For all graded work, students should pledge that they have neither given nor received any unacknowledged aid.

Academic Policy & Procedures

You are responsible for knowing and adhering to academic policy and procedures as published in University Bulletin and Student Handbook. Please note, an incident of behavioral infraction or academic dishonesty (cheating on a test, plagiarizing, etc.) will result in immediate action from me, in consultation with university administration (e.g., Dean of Undergraduate Studies, Student Conduct, Academic Advising). Please visit the Undergraduate Studies website for additional guidance related to academic policy and procedures. Academic integrity is everyone's responsibility.

Please refer to Undergraduate Bulletin and visit the Office of Undergraduate Advising website for DKU course policies and guidelines.

Academic Disruptive Behavior and Community Standard

Please avoid all forms of disruptive behavior, including but not limited to: verbal or physical threats, repeated obscenities, unreasonable interference with class discussion, making/receiving personal phone calls, text messages or pages during class, excessive tardiness, leaving and entering class frequently without notice of illness

or other extenuating circumstances, and persisting in disruptive personal conversations with other class members. Please turn off phones, pagers, etc. during class unless instructed otherwise. Laptop computers may be used for class activities allowed by the instructor during synchronous sessions. If you choose not to adhere to these standards, I will take action in consultation with university administration (e.g., Dean of Undergraduate Studies, Student Conduct, Academic Advising).

Academic Accommodations

If you need to request accommodation for a disability, you need a signed accommodation plan from Campus Health Services, and you need to provide a copy of that plan to me. Visit the Office of Student Affairs website for additional information and instruction related to accommodations.

What campus resources can help me during this course?

Academic Advising and Student Support

Please consult with me about appropriate course preparation and readiness strategies, as needed. Consult your academic advisors on course performance (i.e., poor grades) and academic decisions (e.g., course changes, incompletes, withdrawals) to ensure you stay on track with degree and graduation requirements. In addition to advisors, staff in the Academic Resource Center can provide recommendations on academic success strategies (e.g., tutoring, coaching, student learning preferences). All ARC services will continue to be provided online. Please visit the Office of Undergraduate Advising website for additional information related to academic advising and student support services.

Writing and Language Studio

For additional help with academic writing—and more generally with language learning—you are welcome to make an appointment with the Writing and Language Studio (WLS). To accommodate students who are learning remotely as well as those who are on campus, writing and language coaching appointments are available in person and online. You can register for an account, make an appointment, and learn more about WLS services, policies, and events on the WLS website. You can also find writing and language learning resources on the Writing & Language Studio Sakai site.

Online resources

The authors of the textbook Applied Combinatorics have made some lecture videos and slides available online here.

You may find the following websites helpful not only for this course:

- Math Stack Exchange — Ask questions about mathematics and get answers from other users.
- Wolfram Mathworld — A good place to look up mathematical definitions.

What is the expected course schedule?

💣 Exact topics covered in each week may subject to change.

Week 1	- Introduction to Algorithms - Asymptotic Notations
Week 2	- Divide and Conquer - Dynamic Programming

Week 3	- 💣 Quiz 1 - Greedy Algorithms - Elementary Graph Algorithms Recitation (+Lab): TBA
Week 4	- Minimum Spanning Trees - Shortest Path Algorithms
Week 5	- 💣 Quiz 2 - Linear Programming - Duality - Maximum Flow
Week 6	- Randomized Algorithms - Hash Tables
Week 7	- 💣 Quiz 3 - P and NP - NP-Completeness - Approximation Algorithms