East China Normal University
GEC International Summer School

CPP31: Data structures and Algorithms 2

Term: June 16th to July 18th, 2025
Class Hours: Monday through Friday, 110 minutes each day (2,750 minutes in total)
Instructor: Sihao Chen
Home Institution: TBD
Office hours: TBD
Email: TBD

Course Description

This course is a continuance to CPP21 Data Structures and Algorithms 1. Design and analysis of algorithms is an important part of computer science today. In this advanced course, we are going to have a broad and deep exposure to algorithmic advances letting students understand how to handle big data, handling intractability, and uncertainty by developing necessary algorithms techniques.

*Prerequisite: MAT24 Discrete Mathematics **AND** CPP21 Data Structures and Algorithms 1*

Learning Objective

Upon completion of this course, students should be able to:

-Use and explain algorithm design tools discussed including divide and conquer, randomization, dynamic programming, and network flows
-Use and explain analytical tools and frameworks discussed including minimax optimality, and analysis within different concrete models, and potential functions.
-Understand and explain important concepts in complexity theory including NP, Co-NP, and NP-Completeness.
-Identify and critique incorrect analyses, find counterexamples to faulty claims and "proofs" of correctness.

Recommended Text

There will be no required textbook, as the course notes are self-contained. However, we do recommend the following textbook:

Algorithm Design, Eva Tardos, 2006.

Course Hours

The course has 25 class sessions in total. Each class session is 110 minutes in length, for a total of 2750 minutes of in-class time. The course meets from Monday to Friday. ECNU awards 3 credits for this course. Different universities may count course credits differently. Consult officials at your own home institution.

Attendance

Summer school is very intense and to be successful, students need to attend *every class*. Occasionally, due to illness or other unavoidable circumstance, a student may need to miss a class. ECNU policy requires a medical certificate to be excused. Any absence may impact on the student's grade. Moreover, ECNU policy is that a student who has more than 3 absences will fail the course. Arriving late or leaving early will count as a partial absence.

Grading Policy

ECNU awards grades of A, A-, B+, B, B-, C+, C, D, and F. Most colleges and universities do not award transfer credit for grades of D or F.

In this course, grading will be based on the following:

Assignments*5	4%*5=20%
Midterm Exams*2	20%*2=40%
Final Exam	40%

General Expectations

Students are expected to:

- Attend all classes and be responsible for all material covered in class and otherwise assigned. Any unexcused absence may impact a student's grade.
- Arrive to class on-time: Late arrivals are disruptive to your fellow students and to the conduct of the class.
- Complete the day's required reading and assignments before class
- Review the previous day's notes before class; make notes about questions you have about the previous class or the day's reading
- Refrain from texting, phoning or engaging in computer activities unrelated to class during class (不要用手机) It is highly disrespectful to the professor and to the class.
- Participate in class discussions and complete required written work on time.

Course Schedule

The planned schedule sketched out below may be modified to suit the interests or abilities of the enrolled students or to take advantage of special opportunities or events that may arise during the term.

Week 1

- *Day 1*
  - *Course outline*
  - *1.1 Network Flow Problems*
  - *1.2 Ford-Fulkerson Algorithm*
- *Day 2*
  - *1.3 Cuts and Min-Cut Problem*
  - *1.4 The Fattest Path Algorithm*
- *Day 3*
  - *1.5 Bipartite Matching Problem*
  - *1.6 Min Vertex Covering Problem and Konig's Theorem*
- *Day 4*
  - *1.7 Baseball Elimination Problem*
  - *2.1 Introduction to Linear Programming*
  - *Assignment 1 due*
- *Day 5*
  - *Lab/Tutorial: Assignment 1 discussion*

Week 2

- *Day 1*
  - *2.1 Introduction to Linear Programming*
  - *2.2 Modelling Problems as Linear Programs (I)*
  - *2.3 Geometric Interpretation of Linear Programming*
- *Day 2*
  - *2.4 Simplex's Algorithm*
  - *2.5 Linear Programming in Standard Forms and Vector Forms*
- *Day 3*
  - *Midterm 1 Review*
- *Day 4*
  - *Midterm 1, covering sections 1.1-2.3*
  - *Assignment 2 due*
- *Day 5*
  - *Lab/Tutorial: Assignment 2 discussion*

Week 3

- *Day 1*
  - *2.6 Duality and Complementary Slackness*
  - *2.7 Modelling Problems as Linear Programs (II)*
- *Day 2*
  - *Discussion about midterm 1*
  - *3.1 P, NP, CoNP and EXP*
  - *3.2 Polynomial Reduction*
- *Day 3*
  - *3.3 NP Complete*
  - *3.4 More NP Complete Problems*
- *Day 4*
  - *3.4 More NP Complete Problems*
  - *Assignment 3 due*
- *Day 5*
  - *Lab/Tutorial: Assignment 3 discussion*

Week 4

- *Day 1*
  - *Midterm 2 Review*
  - *3.4 More NP Complete Problems*
- *Day 2*

    - *Midterm 2, covering sections 2.1-3.4*
- *Day 3*
    - *3.4 More NP Complete Problems*
    - *3.5 PSPACE*
- *Day 4*
    - *4.1 Vertex Cover Problem*
    - *4.2 Load Balancing Problem*
    - *Assignment 4 due*
- *Day 5*
    - *Lab/Tutorial: Assignment 4 discussion*

Week 5

- *Day 1*
    - *Discussion about midterm 2*
    - *4.3 The Center Selection Problem.*
- *Day 2*
    - *4.4 Weighted Set Cover Problem.*
    - *4.5 PTAS Algorithm*
- *Day 3*
    - *Section 5 Randomized Algorithms*
- *Day 4*
    - *Final Exam Review*
    - *Assignment 5 due*
- *Day 5*
    - *Final exam, covering Sections 1-5*

Academic Honesty

Students are expected to maintain high standards of academic honesty. Specifically, unless otherwise directed by the professor, students may not consult other students, books, notes, electronic devices or any other source, on examinations. Failure to abide by this may result in a zero on the examination, or even failure in the course.