

Fall 2024 COMS W6998 Section 4

Advanced Topics in Competitive Programming (Tentative) Syllabus

Authors: Josh Alman and Christian Yongwhan Lim

Last Updated: Tuesday, September 3, 2024

Instructors

- Josh Alman
- Christian Yongwhan Lim

Teaching Assistant

- Benjamin Rubio

Office Hours

- Email us any time to schedule an office hour.

Lectures

- Mondays and Wednesdays, from 5:40pm ET to 6:55pm ET @ 558 EXT Schermerhorn Hall

Grade Options

- Letter grade is strongly encouraged, but P/D/F is possible.

Course Website

- All course materials will be posted on Columbia Courseworks:
<https://courseworks2.columbia.edu/courses/203133>

Course Contract

- You must sign the [Course Contract](#) by the first Friday once you join the course successfully.

(Growing) Short List of Useful Websites

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Prerequisites

- GPA of 3.8+ is highly recommended.
- **Required** to pass the diagnostic test with a score of at least 8/10, due by **Monday September 9**; a failure to do so will result in automatic C- or below in your final grade.
- Recommended prerequisites are:
 - COMS 3134: Data Structure in Java or COMS 3136: Essential Data Structures in C/C++;
 - COMS 3203: Discrete Mathematics;
- Knowledge of C++ or Java or Python is highly recommended.
- Some exceptions may be granted by the instructor on a case-by-case basis (e.g., transfer students).

Recommended Textbooks

- Competitive Programming 4, Halim et. al.
- Guide to Competitive Programming, Laaksonen

Course Objectives

Upon successful completion of the course, you will have exposure to multiple advanced topics necessary to do well in the World Finals of the International Collegiate Programming Contest series. We will go over topics and strategies required to succeed in the competitive programming contests!

Allowed Languages

As you are preparing for competitive programming contests, I strongly recommend that you pick one of the following languages, with a strict preference given to C++:

- C/C++;
- Python;
- Java;

If you would like to use a language that is not listed in the list above, please discuss your language preference with the instructors **BEFORE** you submit your deliverables in the first week.

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Expectations

We expect the following of students in this class. In the remainder of this document we go into more detail about each one.

- Pass (i.e., get a score of 8/10 or better) the diagnostic test by Monday, September 9.
- Attend lectures on Mondays and Wednesdays.
- Submit correct solutions to at least half of the homework problems.
- Present at least 7 solutions to assigned problems (from Wednesdays) at Monday lectures.
- Participate in at least 7 practice contests on Sunday afternoons.
- Participate in a mirror of ICPC World Finals on September 19.
- Participate in the ICPC North America Qualifier (NAQ) on October 5.
- Participate in the Columbia University Local Contest in October.
- Participate in the ICPC Greater New York Regional Contest, if qualified, on November 10.
- Participate in at least 5 live CodeForces contests throughout the semester.

Exams

No Exam (Midterm or Final)

Course Structure

Each week, we will have:

- On Mondays and Wednesdays, there will be a *75-minute* lecture with **required attendance** (in-person).
- On Sundays from 1pm ET to 6pm ET, there will be a 5-hour practice contest (in-person).
- Weekly: On Mondays at 9am ET, there will be a 1-week ICPC weekly practice contest (online).
- Weekend: From Fridays to Sundays, there will be a 48-hour ICPC weekend practice contest (online).
- Throughout the week, there will be Codeforces contests (online).

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Lecture Format

- Lectures will be Mondays and Wednesdays, from 5:40pm ET to 6:55pm ET.
- Each Wednesday, Josh or Christian will give a lecture introducing some programming contest topics. We will assign a list of homework problems relating to that topic at the end of class, which are due the following Monday before class.
- Over the course of the semester, you are expected to submit correct solutions to at least half of all the homework problems.
- Towards the end of each Wednesday lecture, a team will pick a problem or two from the homework that they wish to present the next Monday by preparing a solution slide deck for the problem.
- In Monday's lectures, each rotating representative from all teams will give a presentation on a problem or two the team chose the previous week. After all the presentations are done, the instructor will provide additional exercises that are representatives from the contents covered during the presentations. We will also go through questions from the Sunday practice contests.

ICPC Practice Contests

- There are many different practice opportunities available. Students are expected to attend at least 7 of the Sunday practices in person. See below for more details.
- Every Sundays (In-Person)
 - from 1pm ET to 6pm ET contest; from 6pm ET to 7pm ET discussion
- Weekly (Online)
 - Mondays: from 9am ET to 9am ET
- Weekend (Online)
 - Fridays: from 5pm ET to Sundays 5pm ET
 - Sundays: Masterclass at 6:30pm ET

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Weekly Presentations

For the presentation, you need to pick a problem from a list of questions that are posed at the end of the lecture. Throughout the semester, you are expected to do at least 7 presentations, each lasting about 15 ~ 20 minutes.

If you need help with preparing the presentations, you are more than welcome to ask the instructors for help.

External Resources

To prepare presentations, it is **OK** to consult external resources (including, but not limited to, programming libraries, solutions from other solvers online, or free discussions with other classmates). But when you do, to avoid plagiarism, you are expected to **cite the source explicitly** at the top of your submission/presentation as a comment; this is just good practice in general. Even if the source is cited, you will receive the point you deserve. It is crucial to remember that your purpose here is to **learn something new**, not to submit blindly. Therefore, you are expected to know the solution to the problems you correctly submitted; once prompted by the instructor, you are expected to walk through the main idea of the solution.

In general, external resources are **acceptable** for the weekly presentation, homework problems, and practice sessions, but **not acceptable** for the diagnostic test or live contests.

As the instructors take the proper citation very seriously, failure to do a proper citation will result in automatic C- or below and your team will be referred to the office.

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Live Contests

The best way to prepare for the programming contest is for you to fully immerse yourself into the timed environment where you work on real contest questions. Based on this philosophy, we require your participation in **LIVE** programming contests from CodeForces. Please note that you need to participate in the **LIVE** contest when the contest is held (so, a virtual contest will **NOT** count; a virtual contest is a mock contest that you can choose to take after the actual contest has taken place).

You must participate in at least 5 live CodeForces contests throughout the semester, and you will receive **one live contest point per correctly solving a problem** from live contests.

For live contests, you are expected to **NOT** use any external resources. Please take a look at CodeForces Contest Rules written by Mike Mirzayanov [here](#). Especially, take a careful note of the "Can-do's and Can't-do's" section. The instructors take these rules very seriously, failure to follow them will result in automatic C- or below and you will be referred to the office.

ICPC World Finals Simputation

You are **expected** to do a **simulation practice/mirror contest** on **September 19** for the ICPC World Finals.

[ICPC Columbia University Local Contest \(CULC\)](#)

You are **expected** to participate in this contest; you should plan for **in-person** participation. It will be held in October 2024, time and location TBD. You will receive assignment points equivalent to the number of solutions you correctly solved, if you successfully participate in this contest. This is an individual, not a team, contest. If you do well, this will be used to form your team to represent Columbia at the Greater New York ICPC Regionals.

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Weekly Practice Contests

You are expected to participate in Sunday practice contests (1-6pm contest, 6-7pm discussion). These can be done with your team of up to three students, but participating solo is also acceptable. You must participate in at least 7 Sunday practices, and are encouraged to participate in all that you are available for. In each practice contest, all the team members must be present, with an expectation of equal contributions. You may change team members during the semester but you need explicit permission from the instructor if you wish to do so. For those who do not already have a team, the practice will be done individually until a team can be matched. Most of the practice contests will be from the ICPC World Finals. We will go over the solutions on Mondays.

For practice contests, it is **OK** to consult external resources but only when your submission is accompanied by a proper citation. In addition, when prompted to explain a solution your team submitted in the practice contest, one of your team members is expected to explain the full solution to the problem. As the instructors take the proper citation very seriously, failure to do a proper citation will result in automatic C- or below and you will be referred to the office.

If you solve a problem during the practice contest, you will be awarded **one practice contest point per correctly solving a problem**.

ICPC Practice Contests through Online Training for Competitive Programming (default mode: online)

You may also participate in other online practice contests with your team of up to three students, where a solo contest is permissive too. The weekend practice contests will be held on Fridays at 5pm ET until 5pm Sundays at 5pm ET. The weekly practice contests will be held every Monday at 9am ET for one full week.

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Problem-Setting

You are encouraged to write problems for a high school contest. If you would like to learn more about it, feel free to ask instructors by email.

Discord

The discord groups that we encourage you to join are:

- ICPC GNYR: <https://discord.gg/nb4f2brKdw>
- Problem Solving Warriors: <https://discord.gg/HEkTf9RhME>
- ICPC Training Warriors: <https://discord.gg/mAUGf3Zxx8>
- Quant Warriors: <https://discord.gg/4v2rUXyst9>
- Programming Zealots: <https://discord.gg/BWUxqnkYhc>

Terse Guides

- Please take a look at the Google Drive [folder](#) that contains some terse guides on contest and interview preparations.

Policy on Academic Honesty

Students are expected to do their own work on all tests and assignments for this class and act in accordance with the Faculty Statement on Academic Integrity and Honor Code established by the students of Columbia College and the School of General Studies. Because any academic integrity violation undermines our intellectual community, students found to have cheated, plagiarized, or committed any other act of academic dishonesty can expect to get at most C- in the course and may be referred to the Dean's Discipline process. Using templates from online is strictly permitted but make sure to properly cite them.

It is students' responsibility to ensure their work maintains the standards expected and should you have any questions or concerns regarding your work, you can:

- Talk with your TA,
- Ask the instructor, or
- Refer to the Columbia University Undergraduate Guide to Academic Integrity.

See also the Course Contract.

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(Tentative) Weekly Topics to Cover

Dates	Topics
September 4, 2024	Lecture 1 [Josh & Christian] Logistics [Josh] Randomized Algorithm Casework Strategies
September 11, 2024	[Josh] Lecture 2: Linear Programming
September 18, 2024	[Skip] Lecture 3: World Finals Simulation on 9/19 instead!
September 25, 2024	[Christian] Lecture 4: Fast Fourier Transform
October 2, 2024	[Christian] Lecture 5: Number Theory
October 9, 2024	[Christian] Lecture 6: Flow + Min Cost Max Flow
October 16, 2024	[Josh] Lecture 7: (Enumerative) Combinatorics
October 23, 2024	[Guest Lecturer] Lecture 8: Combinatorial Games (Grundy Numbers)
October 30, 2024	[Christian] Lecture 9: Dynamic Programming Optimization
November 6, 2024	[Josh] Lecture 10: Geometry
November 13, 2024	[Christian] Lecture 11: Strings
November 20, 2024	[Josh] Lecture 12: Advanced Topics
December 4, 2024	[Guest Lecture: Etienne Vouga] Lecture 13: Geometry Revisited