



Roadmap For COMPETITIVE PROGRAMMING

INTRODUCTION:

➡ What is CP ?

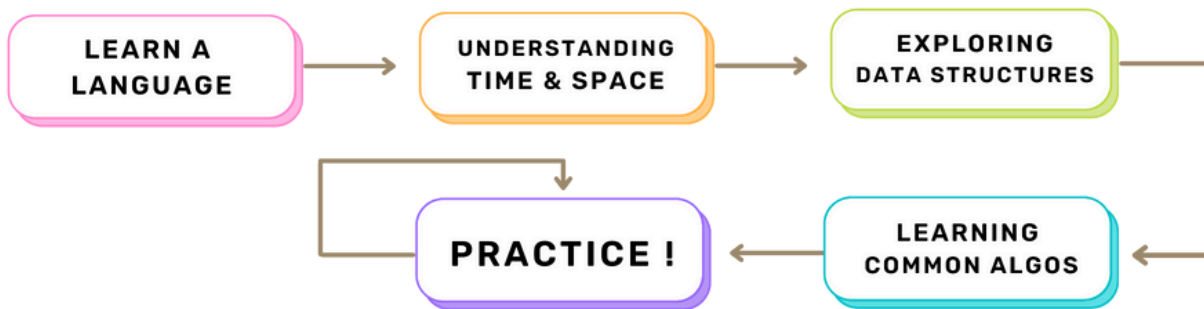
It's a mind-sport where you are given a problem and have to develop optimised solutions for the given constraints with your coding skills. This helps us in building our logical and analytical thinking skills and also in enhancing our knowledge.

Now, the question is how we can do Competitive Programming.

➡ Various CP Platforms

- ◇ An online judge is an online system to test programs in programming contests. It runs the code for test cases which are hidden and compares it with the expected output within the memory and time limits imposed.
- ◇ Some Popular CP Platforms are -
 - [Codeforces](#) (*We will see more about it further*), [Codechef](#), [Atcoder](#), [Topcoder](#), [Hackerrank](#), [Leetcode](#) etc.
- ◇ Some Popular Coding Cups / Hackathons -
 - [Intercollegiate Programming Contest \(ICPC\)](#): The competition consists of teams of three students, who are given a set of algorithmic problems to solve within a fixed time frame (usually 5 hours)
 - [Hacker Cup](#)-Facebook Meta's annual open programming competition.
 - [ICFP](#)- A three-day open programming competition.

GETTING STARTED:



What's better than some advice from the best to get started

- [How to start Competitive Programming? For beginners!](#)
- [How To Become Red Coder? \(codeforces.com\)](#)

➡ Pre-Requisites

What text editor should I use?

Some of you may have thought about which editor to be used for competitive programming. Well, some of the good editors for CP are Sublime Text (for both Linux and Windows), CodeBlocks (for Windows only), and Geany. However, if someone still uses online editors (GeeksForGeeks, Codeforces, Ideone, or CodeChef IDE), switch to offline editors as soon as possible. Online editors should not be used during the contests because the site may crash at that time, and you may lose the unsaved code. Also, if you are using Ideone or Pastebin, your code may get stolen, and you might be caught in plagiarism.

Now talking about the offline editors, if you have Linux installed on your laptop, you can easily set up Sublime Text on it. ([Installing Sublime Text on Linux](#), [Set Up Sublime Text in Linux](#)). However, if you are using Windows, try setting up Sublime Text ([Sublime Text for Windows](#)). However, if it is giving any errors which you are not able to resolve, then you can set up CodeBlocks easily on your system. You can also set up Geany on your Linux system if you want.

[Linux setup for Competitive Programming \(with Geany\)](#)

→ Week I & II

✧ So, in the first week, we will start with the most essential things required for CP, which are Learning and Understanding Time and Space Complexity.

✧ On the language part, we would be learning C++ because it's the most commonly used language in CP for two main reasons:

- a. It's *faster than any other programming language* in terms of speed.
- b. It has a very *vast Standard Template Library*.

✧ **BREAKDOWN -**

DAY 1 & 2	<p>On Day-I & II , we will be covering the sheer basics of C++, with Basic Syntax, I/O and Variables</p> <p>Introduction to C++ -</p> <ul style="list-style-type: none">- Basic Syntax and Structure- Input/Output in C++- Comments in C++ <p>Variables and Data Types -</p> <ul style="list-style-type: none">- Variables and Literals- Fundamental Data Types in C++- Typecasting in C++- Scope of a Variable- Operators in C++
DAY 3 & 4	<p>Moving on we would be covering The flow Control in C++. Now, what is Flow Control? Flow control statements serve to specify what has to be done by our program, when, and under which circumstances. It includes Conditional Statements and Loops.</p> <p>Conditionals in C++ -</p> <ul style="list-style-type: none">- If-Else Statements- Switch-Case Statements- Ternary Operator(Substitute for if-else) <p>Loops in C++ -</p>

	<ul style="list-style-type: none"> - While and do-While Loops - For Loop - Break and Continue statements
DAY 5 & 6	<p>Moving on to Day-V & VI we would be covering the most fundamental kind of data structure in C++ which is an Array. We will also cover the implementation Of string (both C-Style and string Object). We would also introduce you To pointer and Dereferencing.</p> <p>Arrays in C++ -</p> <ul style="list-style-type: none"> - Introduction to Arrays - Multidimensional Arrays <p>Strings in C++ -</p> <ul style="list-style-type: none"> - C-Style and C++-Style Strings - More with string Object in C++ <p>Pointers and Dereferencing -</p> <ul style="list-style-type: none"> - Introduction to Pointers - Working with Pointers in Arrays - Dynamic Memory Allocation in C++ <p>PRACTICE TIME !!</p> <ul style="list-style-type: none"> - Reverse words in a given string - https://codeforces.com/problemset/problem/1760/B - https://codeforces.com/problemset/problem/1703/C - https://codeforces.com/problemset/problem/1758/A
DAY 7 & 8	<p>Moving on to Day-VII & VIII we would be wrapping up the things in C++. Today, we will be dealing with Functions in C++ and Recursion.</p> <p>Functions in C++ -</p> <ul style="list-style-type: none"> - How to create Functions? - Default Arguments in a Function - Passing Array to a Function in C++ - Call by Value v/s Call by Reference <p>Recursion -</p> <ul style="list-style-type: none"> - Introduction to Recursion in C++ - Recursion and Backtracking

	<p>PRACTICE TIME !!</p> <ul style="list-style-type: none"> - https://www.codechef.com/problems/FIBXOR01 - https://www.geeksforgeeks.org/partition-set-k-subsets-equal-sum/ - https://www.geeksforgeeks.org/given-a-string-print-all-possible-palindromic-partition/
DAY 9 & 10	<p>It's time we move on to the various coding platforms like Codeforces, Codechef etc. Of these, Codeforces is the main, so we have a detailed overview for you of the judge.</p> <p>For other Judges, the UI is straightforward, and a breakdown of the rating system is provided below.</p> <ul style="list-style-type: none"> - CodeChef - AtCoder - HackerRank - TopCoder <p>It is advised to spend some time on these platforms and familiarise oneself so that one is comfortable with these platforms, as these will be a constant part of the CP Journey.</p>
DAY 11 & 12	<p>On Day-XI & XII, we will discuss the Big-O Notation and its relation to the CP scenario.</p> <ul style="list-style-type: none"> - Introduction to Time Complexity - Big O Notation - Judging Constraints <p>PRACTICE TIME !!</p> <p>As an exercise, you can analyse the time complexity of the problems you have solved till now and figure out the bound of the algorithm used using the Big-O Notation. Trick questions from Time & Space Complexity - Coding Ninjas CodeStudio</p>
DAY 13 & 14	<p>Practise day? Check out the resources given below, like ladders etc.</p> <p>You guys can now do lower-rated Codeforces problems (<1300) on A2OJ Ladders and Introductory Problems on CSES Problem Set...</p>

	A2OJ Ladders CSES Problem Set - Tasks Solve C++ HackerRank
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✧ **SOME EXTRA TOPICS FOR WEEK I -**

(Depends on your interest :)

- [Structs in C/C++](#)
- [Linked List and its Implementation](#)
- [Object Oriented Programming \(OOPS\) in C++](#)
- [Common Errors in C++](#)

➔ **Week - III**

✧ We are going to cover C++'s Standard Template Library or STL in the upcoming two weeks (Week II and III).

What is STL?

STL contains a lot of predefined functions and data structures that can be used in CP. So it becomes important for us to learn STL to improve CP.

You can go through [this link](#) to get an overview of STL.

✧ Since STL has a lot of functions and predefined data structures in STL, it can be overwhelming to go through every one of them. So we will be covering only some of the most useful data structures in STL that you are most likely to encounter during your CP journey.

✧ **BREAKDOWN -**

Day I-II	Iterators - They are very similar to pointers in various ways, it might be a little tricky to fully understand without any prior knowledge of STL containers. But try to read about them from this blog . To iterate over Different containers using a Range-based for loop in C++ provides a sleek syntax.
Day II-III	Sort -

	<p>Here is a link to learn about sort in C++ -Sort</p> <p>Lambda expression - You can read about it from Lambda expression in C++-GeeksforGeeks. These are useful when you want to write custom comparator functions.</p> <p>PRACTICE TIME !!</p> <ul style="list-style-type: none"> - https://codeforces.com/contest/903/problem/C - Ferris Wheel Musical Rods - Problems CodeChef - https://codeforces.com/problemset/problem/492/B - https://codeforces.com/problemset/problem/1545/A <p>Pair -Pair is a relatively simple container, defined in STL, it is used when we want to store two data together. Give it a read from this blog.</p> <p>PRACTICE TIME !!</p> <ul style="list-style-type: none"> - The Monk and Class Marks Practice Problems
DAY IV	<p>Vectors - Vector is a C++ container that is used to store a particular data type. They are very similar to the classical array but have a lot of advantages over them. For more on vector v/s arrays, you can go through the Advantages of a vector over an array in C++. Now give a read to the vectors part of this blog.</p> <p>PRACTICE TIME !!</p> <ul style="list-style-type: none"> - Maximize the sum Practice Problems - Minimum operations Practice Problems - Infinite arrays Practice Problems
DAY V	Binary Search, Lower Bound & Upper Bound -


	<p>Binary search is a searching algorithm in a sorted array that exploits the sorted nature of the array and reduces the time complexity to $O(\log n)$.</p> <p>Lower bound and upper bound are functions that use binary search in their implementation. You can see the applications in the following articles:</p> <ul style="list-style-type: none"> - Binary Search - Algorithms for Competitive Programming - std::upper_bound and std::lower_bound for Vector in C++ STL - GeeksforGeeks <p>PRACTICE TIME !!</p> <ul style="list-style-type: none"> - https://codeforces.com/problemset/problem/1566/A - https://codeforces.com/group/ctEtdi2TSJ/contest/396408/problem/A - https://codeforces.com/group/ctEtdi2TSJ/contest/396408/problem/E
DAY VI	<p>Stacks - Stacks are a type of container with LIFO (Last in First Out) type of work, where a new element is added at one end (top) and an element is removed from that end only. You can refer to this article to learn about syntax and basic functionalities in the stack.</p> <p>PRACTICE TIME !!</p> <ul style="list-style-type: none"> - Parenthesis Checker Practice GeeksforGeeks - https://practice.geeksforgeeks.org/problems/next-larger-element-1587115620/1?page=1&category[]=Stack&sortBy=submissions - Longest valid Parentheses Practice GeeksforGeeks
DAY VII	<p>PRACTICE TIME !!</p> <ul style="list-style-type: none"> - https://codeforces.com/problemset/problem/1183/D - https://www.geeksforgeeks.org/the-stock-span-problem/ - https://codeforces.com/group/ctEtdi2TSJ/contest/384123/problem/H - https://codeforces.com/group/ctEtdi2TSJ/contest/396408/problem/E - https://codeforces.com/problemset/problem/1201/C

→ Week - IV

◇ BREAKDOWN -

DAY I	<p>Queue - Queue is a type of container adapter that operates in a first in first out (FIFO) type of arrangement. More about the queue here and in this blog.</p> <p>PRACTICE TIME !!</p> <ul style="list-style-type: none">- First negative integer in every window of size k Practice GeeksforGeeks- Disk tower Practice Problems
DAY II - III	<p>Map, Unordered-map, Multimap, Unordered_multimap -</p> <p>You can go through different map operations in this blog. Map - Map in C++ Standard Template Library (STL) - GeeksforGeeks Unordered_map - unordered_map in C++ STL - GeeksforGeeks Multimap - Multimap in C++ Standard Template Library (STL) - GeeksforGeeks Unordered_Multimap - unordered_multimap and its application - GeeksforGeeks</p> <p>PRACTICE TIME !!</p> <ul style="list-style-type: none">- https://codeforces.com/contest/4/problem/C- Subarray with 0 sum Practice GeeksforGeeks- Sum of Two Values- CSES - Subarray Sums I
DAY IV- V	<p>Sets, Unordered_set, Multiset, Unordered_Multiset -</p> <p>Set - Set in C++ Standard Template Library (STL) - GeeksforGeeks</p>

	<p>Unordered_set -Unordered Sets in C++ Standard Template Library - GeeksforGeeks</p> <p>Multiset -Multiset in C++ Standard Template Library(STL) - GeeksforGeeks</p> <p>Unordered_multiset -Unordered_multiset and its uses-GeeksforGeeks</p> <p>PRACTICE TIME !!</p> <ul style="list-style-type: none"> - Twice Counter Practice GeeksforGeeks - https://codeforces.com/contest/855/problem/A - https://atcoder.jp/contests/arc087/tasks/arc087_a?lang=en - Monk and the Magical Candy Bags Practice Problems - https://www.geeksforgeeks.org/largest-subset-of-array-having-sum-at-least-0/
DAY VI	<p>Priority Queue - They are containers similar to queue, but the only difference is that the top element is always the maximum of the set.</p> <p>Priority queues are implemented internally using binary search tree. So insertion and deletion are $O(\log n)$.</p> <p>Read more about priority queues in this blog.</p> <hr/> <p>PRACTICE TIME !!</p> <ul style="list-style-type: none"> - Monk and the Magical Candy Bags Practice Problems - K-th Largest Sum Contiguous Subarray Practice GeeksforGeeks
DAY VII	<p>CPPREFERENCE.COM</p> <p>Remember, When in doubt, always refer to: Cppreference.com Now you can create a Template code for yourself But wait, What are template codes? How Should I create one for myself? Templates are some pre-written code that competitive programmers use to make their Coding faster and more efficient.</p> <p>For example, take this Sample Template</p> <hr/>

	<p>To understand this template better, you can go through this doc.</p> <p>Now, that you know a lot of stuff so you are a lot more likely to make a lot of mistakes so here is a video that would be of great help</p> <p> C++ Mistakes Noobs Make (and how to prevent them)</p> <p>By now you are well familiar with C++ STL, so you will be better able to appreciate this blog and use it: C++ TIPS AND TRICKS - CODEFORCES</p>
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→ Week - V

✧ So, in the fourth week, we will be covering some miscellaneous topics that are very much essential as you proceed higher up in the domain of Competitive Programming.

✧ The topics include - Prefix Sums, Number Theory, Dynamic Programming and Bit Masking.

✧ This section is more about practice, the content would be very minimal, but you can improve your grip on these topics by practising more and more...

✧ BREAKDOWN -

DAY I	<p>Prefix Sums -</p> <ul style="list-style-type: none"> - Prefix Sums <p>PRACTICE TIME !!</p> <ul style="list-style-type: none"> - Missing Number - Forest Queries - Problem 2. Subsequences Summing to Sevens - Problem 2. Hoof, Paper, Scissors
DAY II	<p>Number Theory -</p> <ul style="list-style-type: none"> - Number Theory - Sieve of Eratosthenes - GeeksforGeeks (<i>useful for finding primes quickly in a range</i>)

	<p>Modular Inverse - Algorithms for Competitive Programming</p> <p>PRACTICE TIME !!</p> <ul style="list-style-type: none"> - CSES - Exponentiation II - CSES - Counting Divisors - CSES-SumofDivisors - https://codeforces.com/contest/1349/problem/A - https://codeforces.com/contest/1758/problem/D
DAY III	<p>Bit Masking -</p> <ul style="list-style-type: none"> - Bit Manipulation - CF Blog - Bitmasks for beginners <p>PRACTICE TIME !!</p> <p>Try implementing addition and multiplication using bitwise operators only (you can use loops)</p> <ul style="list-style-type: none"> - https://codeforces.com/problemset/problem/1514/B - https://codeforces.com/problemset/problem/1615/B - https://codeforces.com/contest/1758/problem/B - Counting Bits Maximum - Xor Subarray - https://codeforces.com/contest/1207/problem/E - https://codeforces.com/contest/276/problem/D - https://codeforces.com/problemset/problem/1614/C
DAY IV - V	<p>Dynamic Programming -</p> <ul style="list-style-type: none"> - DP - From Novice to Advanced - More Resources for DP <p>PRACTICE TIME !!</p> <p>An excellent idea to solve the entire CSES dynamic programming' section (except the last 2-3 questions).</p> <p>Some selected problems are given below:</p> <ul style="list-style-type: none"> - Coin Combinations I - Coin Combinations II(contrast with the previous problem) - Two Sets II - https://codeforces.com/problemset/problem/455/A - Longest Common Subsequence - LeetCode - CSES - Projects
DAY VI	<p>PRACTICE TIME !!</p> <p>Here are some questions for your practice:</p>

	<ul style="list-style-type: none"> - https://codeforces.com/problemset/problem/1234/C - https://codeforces.com/contest/1557/problem/B - Problem 1. Sleepy Cow Herding - https://codeforces.com/contest/1529/problem/B
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➔ SOME MORE RESOURCES -

✧ Books -

- [Competitive Programmer's Handbook | CSES](#)
- [Guide to Competitive Programming | Springer](#)

✧ Problem Sets and Resources -

- [CSES Problem Set](#)
- [A2OJ Ladders](#)
- [CP-Algorithms](#)

✧ Blogs -

- [Blog: From Rating 1000 to 2400+](#)
- [Blog: From Rating 1000 to 2000](#)
- [75LeetCode Questions to save your time](#)

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