COMP4128 Week 01 Tutorial

Yifan He

z5173587@unsw.edu.au

About me

- Year 1 PhD student, studying the field of logic & general game playing
- Finished CS Honour year in 2022 (Uni Medalist)
- Did this course in 2019 (course prize winner)

$$Div\ 14th \xrightarrow{COMP4128} Region\ 2nd \rightarrow Region\ 2nd$$

2019 2020 2021

Due dates

- Contest 1 (this weekend)
- Problem Set 1 (end of the term)

Outline

- What to expect in COMP4128
- Structure of my tutorial sessions
- Problem solving

More information about COMP4128

What COMP4128 is **not** about

- A WAM booster
- An interview course

More information about COMP4128

What COMP4128 is **not** about

- A WAM booster
- An interview course

What you might take away from COMP4128

- Be smarter?
- Smash interview?
- More advanced DS & algorithms
- Practice problem solving in general

About COMP4128 (cont.)

How to do well
- **Don't** practice leetcode hard problems
- Solve **every** problem set problems **individually**
- Solve similar problems on Codeforces
- You can email me for problem recommendations

Warning
- Don't copy solutions directly
- Use contest 1 to "predict" your success rate

Tutorial Structure

Tutorial Structure

Tutorial

- Might be some revision?
- Solve tutorial question

Tutorial Structure

Tutorial
- Might be some revision?
- Solve tutorial question

Lab
- 1~2 additional related problems
- Q & A
- Marking journals

Please read all problems before coming!

Complete The Word

Give a string of length N ($N \le 50,000$), the string is nice if there exists a substring of length 26 where each letter of 'A' to 'Z' appears exactly once. You are given a string where some of its letters are missing (represented with '?'). Is it possible to fill in the missing letters with 'A' to 'Z' so that the resulting string is nice? If yes, find an example.

Example
input: ABC??FGHIJK???OPQR?TUVWXY?
output: ABCDEFGHIJKLMNOPQRSTUVWXYZ

Complete The Word

How to check if a string can be made nice?

Complete The Word

How to check if a string can be made nice?

- There is a substring of length 26 that can be made nice

Complete The Word

How to check if a string can be made nice?

- There is a substring of length 26 that can be made nice
- All letters in the substring are distinct

Complete The Word

How to check if a string can be made nice?

- There is a substring of length 26 that can be made nice
- All letters in the substring are distinct
- Iterate through all substrings of length 26. For each of them check if the letters in it are distinct.

Complete The Word

How to check if a string can be made nice?

- There is a substring of length 26 that can be made nice
- All letters in the substring are distinct
- Iterate through all substrings of length 26. For each of them check if the letters in it are distinct.
- Check can be done with an array. Time complexity O(26*N).
- Can we make it faster?

Complete The Word

How to check if a string can be made nice?

- There is a substring of length 26 that can be made nice
- All letters in the substring are distinct
- Iterate through all substrings of length 26. For each of them check if the letters in it are distinct.
- Check can be done with an array. Time complexity O(26*N).
- Can we make it faster?
- Yes, sliding windows!

Complete The Word

How to check if a string can be made nice?

- There is a substring of length 26 that can be made nice
- All letters in the substring are distinct
- Iterate through all substrings of length 26. For each of them check if the letters in it are distinct.
- Check can be done with an array. Time complexity O(26*N).
- Can we make it faster?
- Yes, sliding windows!
- Maintain a window of size 26, and dynamically maintain (#distinct letters, #letters), and check they are equal. Time complexity O(N).

Complete The Word

How to complete the string to be nice?

Complete The Word

How to complete the string to be nice?
- Locate the "all distinct" substring

Complete The Word

How to complete the string to be nice?

- Locate the "all distinct" substring
- Detect the missing letters

Complete The Word

How to complete the string to be nice?

- Locate the "all distinct" substring
- Detect the missing letters
- Replace the '?' with the missing letters

Complete The Word

How to complete the string to be nice?

- Locate the "all distinct" substring
- Detect the missing letters
- Replace the '?' with the missing letters
- Don't forget about '?' in other substrings.

Complete The Word

How to complete the string to be nice?

- Locate the "all distinct" substring
- Detect the missing letters
- Replace the '?' with the missing letters
- Don't forget about '?' in other substrings.
- Just fill it with 'A'.

Match Points [1]

You are given a set of points $x_1, x_2, ..., x_n$ on the number line. Two points i and j can be matched with each other if the following conditions hold:
• neither i nor j is matched with any other point;
• $|x_i - x_j| \geq z$.
What is the maximum number of pairs of points you can match with each other?
• $2 \leq n \leq 200,000$ and $1 \leq z \leq 10^9$

Match Points [1]

You are given a set of points $x_1, x_2, ..., x_n$ on the number line. Two points i and j can be matched with each other if the following conditions hold:
• neither i nor j is matched with any other point;
• $|x_i - x_j| \geq z$.
What is the maximum number of pairs of points you can match with each other?
• $2 \leq n \leq 200,000$ and $1 \leq z \leq 10^9$

Example

n = 4, z = 2
x = [1, 3, 3, 7]

[1] https://codeforces.com/contest/1156/problem/C

Match Points

Can we do greedy matching?

- Obvious first step is sorting

Match Points

Can we do greedy matching?

- Obvious first step is sorting
- Iterate from the largest x_n, match it with the largest x_i such that $|x_n - x_i| \geq z$?

Match Points

Can we do greedy matching?

- Obvious first step is sorting
- Iterate from the largest x_n, match it with the largest x_i such that $|x_n - x_i| \geq z$?
- Wrong answer!
- N = 6, Z = 9
- 1 2 3 10 13 19
- But a better solution is 1 2 3 10 13 19

Match Points

A Modified Problem

Match Points

A Modified Problem
- Can you check if there exists a match of size K?

Match Points

A Modified Problem

- Can you check if there exists a match of size K?
- $K \leq N/2$

Match Points

A Modified Problem

- Can you check if there exists a match of size K?
- $K \leq N/2$
- There is a match of size K iff the match $(x_1, x_{N-K+1}), (x_2, x_{N-K+2}), ..., (x_K, x_N)$ is good.

Match Points

A Modified Problem

- Can you check if there exists a match of size K?
- $K \leq N/2$
- There is a match of size K iff the match $(x_1, x_{N-K+1}), (x_2, x_{N-K+2}), ..., (x_K, x_N)$ is good.
- Can be proved by the exchange argument

Match Points

A Modified Problem

- Can you check if there exists a match of size K?
- $K \leq N/2$
- There is a match of size K iff the match $(x_1, x_{N-K+1}), (x_2, x_{N-K+2}), ..., (x_K, x_N)$ is good.
- Can be proved by the exchange argument
- If there is a match of size K, can we find a match of size K-1?

Match Points

A Modified Problem

- Can you check if there exists a match of size K?
- $K \leq N/2$
- There is a match of size K iff the match $(x_1, x_{N-K+1}), (x_2, x_{N-K+2}), ..., (x_K, x_N)$ is good.
- Can be proved by the exchange argument
- If there is a match of size K, can we find a match of size K-1?
- Binary search to find the maximum K!