

CS 170 Homework 1

Due Monday 1/30/2023, at 10:00 pm (grace period until 11:59pm)

1 Study Group

List the names and SIDs of the members in your study group. If you have no collaborators, you must explicitly write “none”.

2 Course Policies

- (a) Homework is due Mondays at 10:00pm, with a late deadline at 11:59pm. At what time do we recommend you have your homework finished?
- (b) We provide 2 homework drops for cases of emergency or technical issues that may arise due to homework submission. If you miss the Gradescope late deadline (even by a few minutes) and need to submit the homework, what should you do?
- (c) What is the primary source of communication for CS170 to reach students? We will send out all important deadlines through this medium, and you are responsible for checking your emails and reading each announcement fully.
- (d) Please read all of the following:
 - (i) **Syllabus and Policies:** <https://cs170.org/syllabus/>
 - (ii) **Homework Guidelines:** <https://cs170.org/resources/homework-guidelines/>
 - (iii) **Regrade Etiquette:** <https://cs170.org/resources/regrade-etiquette/>
 - (iv) **Forum Etiquette:** <https://cs170.org/resources/forum-etiquette/>

Once you have read them, copy and sign the following sentence on your homework submission.

“I have read and understood the course syllabus and policies.”

3 Understanding Academic Dishonesty

Before you answer any of the following questions, make sure you have read over the syllabus and course policies (<https://cs170.org/syllabus/>) carefully. For each statement below, write *OK* if it is allowed by the course policies and *Not OK* otherwise.

- (a) You ask a friend who took CS 170 previously for their homework solutions, some of which overlap with this semester's problem sets. You look at their solutions, then later write them down in your own words.
- (b) You had 5 midterms on the same day and are behind on your homework. You decide to ask your classmate, who's already done the homework, for help. They tell you how to do the first three problems.
- (c) You specifically look up a homework problem online and find the exact solution. You then write it in your words and cite the source.
- (d) You were looking up Dijkstra's on the internet, and inadvertently run into a website with a problem very similar to one on your homework. You read it, including the solution, and then you close the website, write up your solution, and cite the website URL in your homework writeup.

4 Recurrence Relations

For each part, find the asymptotic order of growth of T ; that is, find a function g such that $T(n) = \Theta(g(n))$. In all subparts, you may ignore any issues arising from whether a number is an integer.

- (a) $T(n) = 3T(n/3) + 9n$
- (b) $T(n) = 4T(n/2) + n^3$
- (c) $T(n) = T(5n/13) + T(12n/13)$ (We have $T(1) = 1$)

5 The Resistance

We are playing a variant of The Resistance, a board game where there are n players, k of which are spies. In this variant, in every round, we choose a subset of players to go on a mission. A mission succeeds if no spies are chosen to go on the mission, but fails if at least one spy goes on the mission, and when a mission fails we are not told who the spies are that went on the mission.

Come up with a strategy that identifies all the spies in $O(k \log(n/k))$ missions. Only a main idea and runtime analysis are needed. (*Hint:* Can you come up with an efficient strategy for $k = 1$? What about for $k = 2$?)

6 Werewolves

You are playing a party game with n other friends, who play either as werewolves or villagers. You do not know who is a villager and who is a werewolf, but all your friends do. There are always more villagers than there are werewolves.

Your goal is to identify one player who is certain to be a villager.

Your allowed ‘query’ operation is as follows: you pick two people as partners. You ask each person if their partner is a villager or a werewolf. When you do this, a villager must tell the truth about the identity of their partner, but a werewolf doesn’t have to (they may lie or tell the truth about their partner).

Your algorithm should work regardless of the behavior of the werewolves.

- (a) Given a single person, devise an algorithm that returns whether or not that person is a villager using $O(n)$ queries. Just an informal description of your test and a brief explanation of why it works is needed.
- (b) Show how to find a villager in $O(n \log n)$ queries (where one query is taking two people x and y and asking x to identify y and y to identify x).

There is a linear-time algorithm for this problem, but you cannot use it here, as we would like you to get practice with divide and conquer.

Hint: Split the group into two groups, and use part (a). What invariant must hold for at least one of the two groups?

Give a 3-part solution.

- (c) (**Extra Credit**) Can you give a linear-time algorithm?

Hint: Don’t be afraid to sometimes ‘throw away’ a pair of people once you’ve asked them to identify their partners.

Give a 3-part solution.

7 Coding Question

Throughout this semester we're going to have short coding exercises so that you can get a feel of what it's like to implement these amazing algorithms that you learn about in lecture in real code. While the notebook may seem large, the actual code you have to write will usually be very short and direct.

For this week's homework, we'll be going over the binary search algorithm in a python jupyter notebook called `binary_search.ipynb`. There are two ways you can access the notebook and complete the problems:

1. Click [here](#) and navigate to the HW1 folder if you prefer to complete this question on Berkeley DataHub.

2. Run

```
git clone https://github.com/Berkeley-CS170/cs170-coding-notebooks-sp23
```

in your computer's terminal (and navigate to the HW1 folder) if you prefer to complete it locally.

Notes:

- In the HW1 folder, you'll see another file called `utils.py`. You can ignore it; all the relevant materials you will need for this assignment are located in `binary_search.ipynb`.
- *Submission Instructions:* Please download your completed `binary_search.ipynb` file and submit it to the gradescope assignment titled "Homework 1 Coding Portion".
- *OH/HWP Instructions:* While we will be providing conceptual help on the coding portion of homeworks, OH staff will not look at your code and/or help you debug.
- *Academic Honesty Guideline:* We realize that code for some of the algorithms we ask you to implement may be readily available online, but we strongly encourage you to not directly copy code from these sources. Instead, try to refer to the resources mentioned in the notebook and come up with code yourself. That being said, we **do acknowledge** that there may not be many different ways to code up particular algorithms and that your solution may be similar to other solutions available online.